Installation instructions

PA 8000 LW

CNC control unit

POWER AUTOMATION

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1 General information

1.1 Information on this manual

General Information

This installation manual provides important information on how to work with the control unit safely and efficiently.

The installation manual is part of the control unit, must always be kept in the control unit's direct proximity and should be available for the personnel at any time. All personnel working with the control unit are obliged to have read and understood this installation manual before starting any work. Strict compliance with all specified safety notes and instructions is a basic requirement for safety at work.

Moreover, the accident prevention guidelines and general safety regulations applicable at the place of use of the control unit must also be complied with.

Illustrations in this installation manual are intended to facilitate basic understanding, and may differ from the actual design of the control unit.

The enclosed manuals for the installed components apply together with this installation manual.

1.2 Explanation of symbols

Warnings

Warnings are identified by pictures. These warnings are introduced by signal words, which express the severity of a danger.

Pay attention to these warnings and act cautiously in order to avoid accidents, personal injuries and damage to property.

DANGER!

… indicates an imminently hazardous situation which, if unavoidable, will result in death or serious injury.

WARNING!

… indicates a potentially hazardous situation which, if unavoidable, could result in death or serious injury.

CAUTION!

… indicates a potentially hazardous situation which, if unavoidable, may result in minor or moderate injury.

NOTICE!

… indicates a potentially hazardous situation which, if unavoidable, may result in property damage.

… emphasizes useful hints and recommendations as well as information for efficient and trouble-free operation.

Special Safety Notes

The following symbols are used in connection with the safety notes to highlight particular dangers:

DANGER!

… highlights hazards caused by electric current. There is a danger of serious injury or death if the safety notes are not complied with.

Additional symbols and highlighting

The following symbols and highlights are used to distinguish instructions, descriptions of results, cross-references and other elements inside this manual.

.. Highlights a step as part of a procedure of instructions.

⇨ .. Highlights a state or an automatic process as a result of an instruction.

■ .. Highlights single or unordered instructions and lists.

“Additional symbols and highlighting” on page 8.. Highlights cross-references to chapters or sections of this manual.

[Key].. Highlights captions of buttons, fields and other elements of the software's graphical user interface.

“Menu ➔ Submenu ➔ ”.. Highlights a path to access a menu or submenu in the software's graphical user interface.

`Example/Extract`.. Highlights verbatim examples and extracts from configuration files.

1.3 Limitation of liability

Liability

All information and notes in this installation manual were compiled under due consideration of valid standards and regulations, the present status of technology and our years of knowledge and experience.

Power Automation can not be held liable for damage resulting from:

- disregarding this installation manual
- unintended use
- employment of untrained personnel
- unauthorized conversions
- unauthorized modifications to the software
- technical modifications
- use of unapproved spare parts
- use in conjunction with machines not deemed compatible by Power Automation

In case of customized versions the actual scope of delivery can vary from the explanations and representations in this installation manual, because of the utilization of additional options or due to the latest technical changes.

Apart from this, the obligations agreed upon in the delivery contract, the general terms and conditions, and the delivery conditions of Power Automation and the legal regulations valid at the time of contract apply.

We reserve the right to make technical modifications in order to improve usability.

1.4 Copyright

Copyright

This installation manual is protected by copyright law.

Passing this installation manual on to third parties, duplication of any kind – even in form of excerpts – as well as the use and/or disclosure of the contents without the written consent of Power Automation is not permitted.

Violations oblige to compensation. The right for further claims remains reserved.

1.5 Warranty terms

Material Warranty

The material warranty terms are provided in Power Automation's terms and conditions as well as inside the sales documents.

1.6 Customer service

Service

Our Customer Service is always available for technical information.

For information on whom to contact by phone, fax, e-mail or via the internet, see Power Automation's address on page 2.

Additionally, Power Automation staff is always interested in receiving new information and experiences resulting from the use of our products, which could be of great value for future improvements.

1.7 Glossary

CMOS - Complementary metal-oxide-semiconductor

CNC - Computerized Numerical Control

DDU - Delivered Duty Unpaid

HMI - Human Machine Interface

The graphical user interface provided by the PA software.

IPC - Insulating Piercing Connector

MDI - Manual Data Input

MTBP - Machine Tool Builder's Panel

Panel including the basic requirements for a machine tool operator: emergency stop push button, cycle start and stop push buttons, jog plus and minus push buttons, feed rate and spindle speed override pots and a number of auxiliary push buttons.

NC-Start - Numerical Control Start Button

NC-Stop - Numerical Control Stop Button

PA - Power Automation

PAMIO - Power Automation Modular Input Output

Extendable Superbus based interface allowing connection of additional I/O modules.

PC - Personal Computer

PCI - Peripheral Component Interconnect

Personal computer extension for periphery devices connected to the motherboard.

PLC - Programmable Logic Controller

POU - Program Organization Unit PLC functions, function blocks and programs are POUs

RMS - Rotating Measuring Systems (Encoder)

2 Safety

2.1 Customer's responsibility

The control unit is used for commercial purposes. The operating company is thus subject to the legal obligations concerning industrial safety.

The safety, accident prevention and environmental protection regulations applicable for the area of application of the machine must be complied with, along with the safety notes specified in this installation manual. The following applies in particular:

- The customer must become familiar with the industrial safety regulations and identify additional dangers which may arise due to the specific working conditions at the place of use of the control unit, by means of a risk analysis. These must be converted into operating instructions for operation of the control unit.
- Throughout the time of use of the control unit the customer must check whether the operating instructions created by him correspond to the current status of regulations and standards. Whenever changes in regulations and standards occur, instructions must be adapted accordingly.
- The customer must clearly specify the responsibilities for installation, operation, maintenance, and cleaning.
- The customer must make sure that all employees who have to work with the control unit have read and understood these operating instructions.

  In addition, the customer must train and inform his personnel about potential dangers at regular intervals.

Moreover, the customer is also responsible for keeping the control unit in technically good condition, and therefore the following applies:

- The customer must make sure that the maintenance intervals specified in these operating instructions are complied with.
- The customer must regularly check all safety features for function and completeness.
- The customer must supply his personnel with the necessary protective equipment.

2.2 Personnel requirements

2.2.1 Qualifications

WARNING!

Danger of injury in case of insufficient qualification!

Improper operation can lead to severe personal injuries and/or material damage.

- Only those persons who have been specified in the corresponding chapters of this installation manual should be entrusted with the listed types of work.
- Employ certified experts, if in doubt.

The following qualifications are specified for different areas of activity listed in the installation manual.

Instructed person
was instructed by the operating company about the duties assigned to her/him and the possible dangers that may arise from inappropriate conduct.

Qualified personnel
are able to carry out assigned work and to recognize possible dangers due to professional training, knowledge, and experience as well as profound knowledge of applicable regulations.

Skilled electrician
A skilled electrician is able to carry out assigned work and to recognize and avoid possible dangers due to professional training, knowledge, and experience as well as profound knowledge of applicable regulations.

The skilled electrician has been trained specially for his working environment and he has profound knowledge of relevant standards and regulations.

2.2.2 Unauthorized persons

WARNING!

Danger for unauthorized persons!

Unauthorized persons, who do not meet the requirements described in this installation manual, are not aware of the dangers in the working area.

- Keep unauthorized persons away from the working area.
- If in doubt, address such persons and ask them to leave the working area.
- Interrupt your work as long as unauthorized persons are in the working area.

Only persons who are expected to perform their tasks reliably are permitted as personnel. Persons whose reaction capability is impaired, e.g. through drugs, alcohol or medication are not permitted.

- When selecting personnel, ensure that the personnel can work with the control unit in terms of technical and content aspects.

2.3 Intended use

Intended Use

The control unit is exclusively intended and built for the use described in this installation manual.

The control unit is to be used exclusively to control CNC machines of a supported number of axes which are in accordance with the types cleared by Power Automation. Prerequisite for the intended use of the control unit is proper configuration as described in the installation manuals provided by Power Automation.

Dangers

WARNING!

Beware of unintended use!

Any use exceeding the scope of intended use and/or different application of the control unit can result in hazardous situations.

– Operate the control unit as intended only.
– Observe all instructions in this installation manual.
– Observe the permissible ambient conditions and electromagnetic compatibility mentioned in the technical data.

Claims of any kind for damage resulting from unintended use are void.

The operator is solely responsible for all damage resulting from unintended use.

2.4 Unintended use

Unintended Use

WARNING!

Beware of unintended use!

- In particular, avoid using the control unit for the following purposes as these are regarded as not intended:
  - Operation using software not approved by Power Automation.
  - Operation connected to machines/drives not deemed compatible by Power Automation.
  - Operation using wrong number of axes
  - Wrong or missing execution of the maintenance intervals
  - Operation by not instructed personnel

2.5 Personal protective gear

Wearing of personal protective gear is required to minimize health hazards and damage when working with the control unit.

- Always wear the protective equipment that is necessary for the respective task when working.
- Follow the instructions on personal protective equipment that are listed in this installation manual and other installation manuals provided by Power Automation.
- The environment in which the control unit is installed may require users to wear additional personal protective gear.

  Observe the instructions on personal protective gear provided by the operating company.

Antistatic gloves
for protection of the hands during the work. Wear the antistatic gloves always until the work is finished.

ESD clothing
for protection of components susceptible to electrostatic discharge. Wear the ESD clothing during the work on electrostatic components.

ESD safety pad
for protection of components susceptible to electrostatic discharge. Put the ESD safety pad on the floor before starting to work.

ESD safety shoes
for protection of components susceptible to electrostatic discharge. Wear the ESD safety shoes to protect electrostatic-discharge-sensitive devices due to inadequate derivative electrostatic energy.

Ear protection
for protection of the ears during the work. Wear the ear protection always until the work is finished.

Ground strap
for protection of components susceptible to electrostatic discharge. Wear the ground strap on your wrist and connect it to a suitable equipotential bonding.

Protective glasses
for protection of the eyes during the work. Always wear the protective glasses until the work is finished.

2.6 Specific dangers

The following section lists the residual risks.

- Observe the safety instructions listed here, and the warnings in subsequent chapters of this installation manual, to reduce health hazards and to avoid dangerous situations.

DANGER!
Danger to life caused by electric current!
Touching conductive parts causes a direct danger to life. Damage to insulations or individual components can cause danger to life.

- In the event of damage to insulation, switch off the power supply immediately and have the defective parts repaired.
- Work on the electric system must be carried out only by skilled electricians.
- Before maintenance, cleaning or repair work, switch off the power supply and secure it against being switched on again.
- Do not bridge fuses or make them ineffective. When changing fuses make sure you use the correct amperage.
- Keep moisture away from conductive parts. This can cause short-circuits.
- De-energize the machine for all work on the electrical system.

DANGER!
Uncontrolled operation due to improper installation and configuration!
The control unit's safety relay must be properly integrated into the CNC machine emergency stop chain. Improper wiring and configuration of the safety relay may result in uncontrolled operation of the CNC machine and in consequence may lead to irreversible personal injuries or death.

- Only operate the CNC machine when the safety relay has been properly integrated into the machine emergency stop chain.
- Only let **qualified personnel** (↳ *Chapter 2.2.1 “Qualifications” on page 12*) set up the emergency stop chain.
- For information on safety devices integrated into the machine see the manual supplied by the machine's manufacturer.
- If in doubt regarding the configuration, contact the manufacturers of the CNC machine and the control unit.

WARNING!

Risk of injury due to improper handling of batteries!

Batteries must be handled with special care.

- Do not throw batteries into fire or expose to high temperature. Explosion hazard!
- Do not charge batteries. Explosion hazard!
- Battery fluid leaking due to wrong usage may cause skin irritation. Avoid contact with the battery fluid. In case of contact, flush the battery fluid with large amounts of water. If the battery fluid enters the eyes, flush immediately with water for 10 min. and consult a physician without delay.

CAUTION!

Malfunction due to discharged buffer battery!

The control unit's CMOS settings are buffered by a battery. If this battery is discharged completely the CMOS settings are lost. Malfunctions of the control unit may result.

- For further information, see ↳ *Chapter 8.3 “Troubleshooting chart” on page 111*.

2.7 Safety devices

Safety

DANGER!

Malfunctioning safety devices may pose a fatal risk!

Safety devices must be intact and properly integrated into the control unit's configuration and software in order to guarantee safety.

- Before initial commissioning of the machine, ensure that all safety devices are fully functional and correctly installed.
- Ensure that safety related inputs/outputs of the PAMIO components and the CNC control unit are fully functional and perform as intended.
- Never disable safety devices.
- Heed regulations concerning hardwiring of safety circuits.

Superior Control Units

Superior CNC Control unit or PLC

For information on required connections between the PA control unit and safety devices integrated into the CNC machine see the documentation provided by the machine's manufacturer.

Safety Connector

Safety connector

For information on the safety connector's purpose, specification and wiring see ↳ Chapter 3.6 “Safety connector” on page 68, ↳ Chapter 2.8 “Machine safety” on page 17 and ↳ Chapter 5.5 “Wiring for machine safety” on page 96.

Software

Data safety

For information on data safety see ↳ Chapter 2.10 “Data safety” on page 20.

2.8 Machine safety

Additional Information

For information regarding the safety connector's specification and wiring examples see ↳ *Chapter 3.6 “Safety connector” on page 68* and ↳ *Chapter 5.5 “Wiring for machine safety” on page 96*.

Further Applicable Documents

For information on the machine's safety devices and emergency stop chain see the manual provided by the CNC machine's manufacturer. The manufacturer of the CNC machine is responsible for the proper installation of the emergency stop.

2.8.1 'CNC ready' signal - Emergency stop interlocking

Personal Injury

DANGER!

Injuries due to uncontrolled operation!

An inactive 'CNC Ready' signal represents a safety related situation. The "CNC Ready" relay is switched off when the PA CNC control unit is in a situation where the axes' movements are **not** controlled.

As the axes may continue to move in an uncontrolled manner, the contacts of the "CNC Ready" relay must be used to disconnect the machine's emergency stop safety chain. All actions necessary for safety must be executed in the same way as when the Emergency Stop button is pushed.

- Properly integrate the 'CNC ready' relay into the machine's emergency stop chain.

All safety related actions must ensure that at least all axes movements and spindle rotation (or beam power) are stopped as quickly as possible.

- Refer to the drive manufacturer manual, to determine the best way of stopping movements and other dangerous power on the machine.
- If drive capability does not exist, the use of external braking resistors might be necessary.

  Unbalanced axes have to execute with the mechanical brake.

The contacts for 'CNC Ready' and 'Power OK' are available on connector X19 (see *Chapter 5.5 “Wiring for machine safety” on page 96*).

2.8.2 'Power ok' signal

The "Power ok" relay is triggered by the hardware monitoring of the internal supply voltages and the temperature sensor.

The "Power ok" relay is switched off when the power supplies do not match the allowed range or the internal temperature is too high.

- Use the contacts of the "Power ok" relay to switch off the main power supply of the control unit to avoid any unexpected damages to the control unit.

The contacts for 'CNC Ready' and 'Power OK' are available on connector X19 (see *Chapter 5.5 “Wiring for machine safety” on page 96*).

– *When an external 5V power supply (RMS) is necessary to supply incremental measuring systems, use the corresponding entry in the control unit's drive configuration file (`DriveCfg.ini`) to activate the monitoring of the correct range of these 5 V.*
When the monitoring is activated, an error on this power supply will cause the "Power ok" relay to drop.

2.9 Conduct in a dangerous situation and in case of accidents

Preventive Measures

- Stay informed about locations of first aid equipment (first aid kit, covers, etc.) and fire extinguisher at the site of installation.
- Instruct personnel about accident reporting, first aid and rescue facilities at the site of installation.

In Case Of Accidents

- Disconnect power supply immediately.
- Initiate first aid measures.
- Inform responsible persons at the site.
- Call for rescue service if applicable.

2.10 Data safety

General Information

To ensure the ability to restore critical data in case of control unit or storage malfunctions, internal and external (off-site) backup copies of all files that are critical to proper machine function must be created regularly and kept in a secure environment.

To minimize the chance of data loss, installation of virus and registry protection is recommended.

CAUTION!

Extended system outage in case of data loss!

If backup copies of critical control unit data are not created regularly and kept securely, the control unit configuration would have to be set up from scratch in case of data loss.

- Pay attention to all instructions regarding data safety as given in this and the other installation manuals provided by Power Automation.

2.10.1 File backup

Initial State

A backup solution is preinstalled and configured.

It is neccessary to select and activate the backup-function inside the CNC.

Instructions

Personnel:
- Qualified personnel
- Instructed person

1. Follow the instructions to properly configure the control unit for use with the intended machine.

   For further information on the configuration see the corresponding configuration manual.
2. Ensure that the configuration is functioning as intended.
3. Ensure that the machine data is saved regularly (see *Chapter 9 “Service and return process” on page 113*).
4. Keep a record of all modifications to the configuration done by the operator.
5. Ensure that backups are updated manually in case of modifications to the configuration.

2.10.2 Virus protection

Initial State

Automated regular anti-virus scanning and manual scanning of files copied to the control unit are advised by Power Automation as needed.

An anti-virus software solution is not preinstalled or configured and therefore falls into the user's responsibility.

Personnel: ■ Qualified personnel

1. Install an antivirus software solution. Power automation recommends the software **ESET NOD32 Antivirus**. See www.eset.com.
2. Configure the anti-virus software to regularly and automatically scan the control unit.
3. Ensure that the software's virus definition database is kept up to date.
4. Ensure that all data copied to the control unit is scanned for viruses and malware regardless of the means by which the data reaches the control unit (floppy disk, USB, optical media, serial connections, local/remote network).

2.10.3 Registry protection

Initial State

The software preinstalled on the control unit keeps various entries in the control unit's registry database that are critical for system operation. Therefore registry protection and backup are prerequisites for proper control unit operation.

A registry backup and recovery tool is preinstalled by Power Automation on every control unit.

Instructions

Personnel: ■ Qualified personnel

→ Regularly create backup copies of the the control unit's registry database using the registry backup tool. The preinstalled registry backup tool 'ERUNT' creates a backup automatically with every start of the CNC control unit. Please contact Power Automation if you need to restore your registry (see ↬ *Chapter 9 “Service and return process” on page 113*.

2.11 Environmental protection

CAUTION!

Environmental hazard caused by incorrect handling!

Incorrect handling of environmentally hazardous substances, especially incorrect waste disposal, can cause considerable damage to the environment.

- Do not release environmentally hazardous substances or components into the environment.
- Always properly dispose of environmentally hazardous components/substances in accordance with local law and regulations.

The following environmentally hazardous components or substances are contained in the control unit:

Batteries

Batteries contain toxic heavy metals. They are considered hazardous waste and must be disposed of by approved specialized waste disposal companies.

Electronic Components

Electronic components are considered special waste. They must be properly disposed of.

Power Automation will accept the control unit to properly dispose of its components upon decommissioning.

- Follow the standard return procedure, as described in ↬ *Chapter 9.3 “Return policy and procedure” on page 115*.

2.12 Labels

The following labels are attached to the control unit.

NOTICE!

Readability Of Labels

Over the course of time labels may become dirty or nonreadable for any other reason. Improper input voltages applied due to readability of labels can damage the control unit.

– Keep labels in readable condition at all times.
– Replace damaged labels (not including material warranty seals).
– Replacements can be obtained from Power Automation.

Overview

The labels listed hereunder are located at the positions shown in Fig. 1.

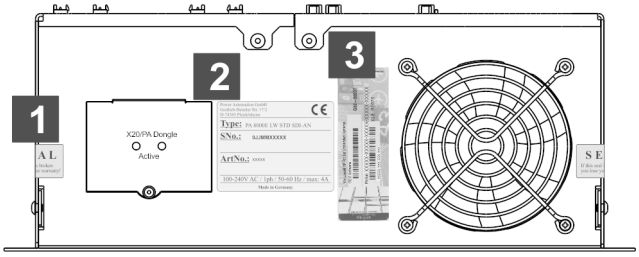


Fig. 1: Label positions

1 Material Warranty seal
2 Type Plate
3 License Operating system

Type Plate

The type plate includes the following information:

- Manufacturer address
- 'CE'-sign
- Control unit model
- Serial number
- Article number
- Connection values

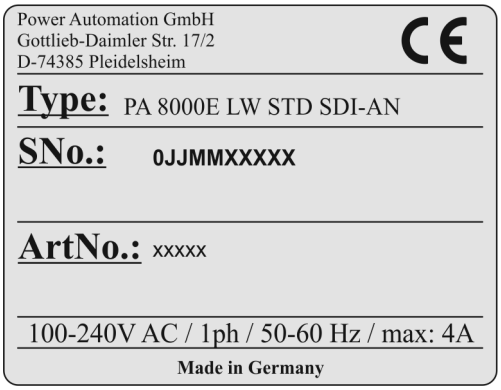


Fig. 2: Type Plate (Example)

Operating System Product Key

The label affixed to the side of the control unit next to the type plate provides the operating system's product key.

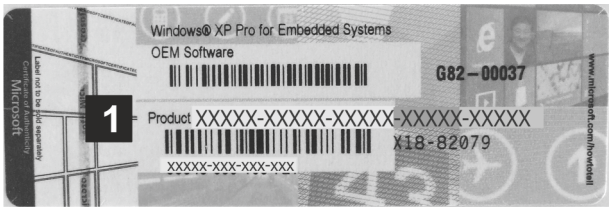
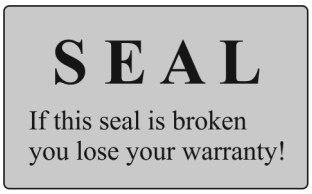


Fig. 3: Windows XP for Embedded Systems operating system license

1 Product key (Serial number)

Material Warranty Seals

The material warranty seals affixed to the control unit at various positions ensure that the control unit's casing is not opened by unauthorized persons.



Broken or removed seals void all material warranty provided by Power Automation.

- *Never open the control unit, or you will lose your material warranty.*
- *Always contact Power Automation, if extensions, repairs or modifications are required (see ↳ Chapter 9 “Service and return process” on page 113).*

3 Design and function

3.1 Overview

Top View

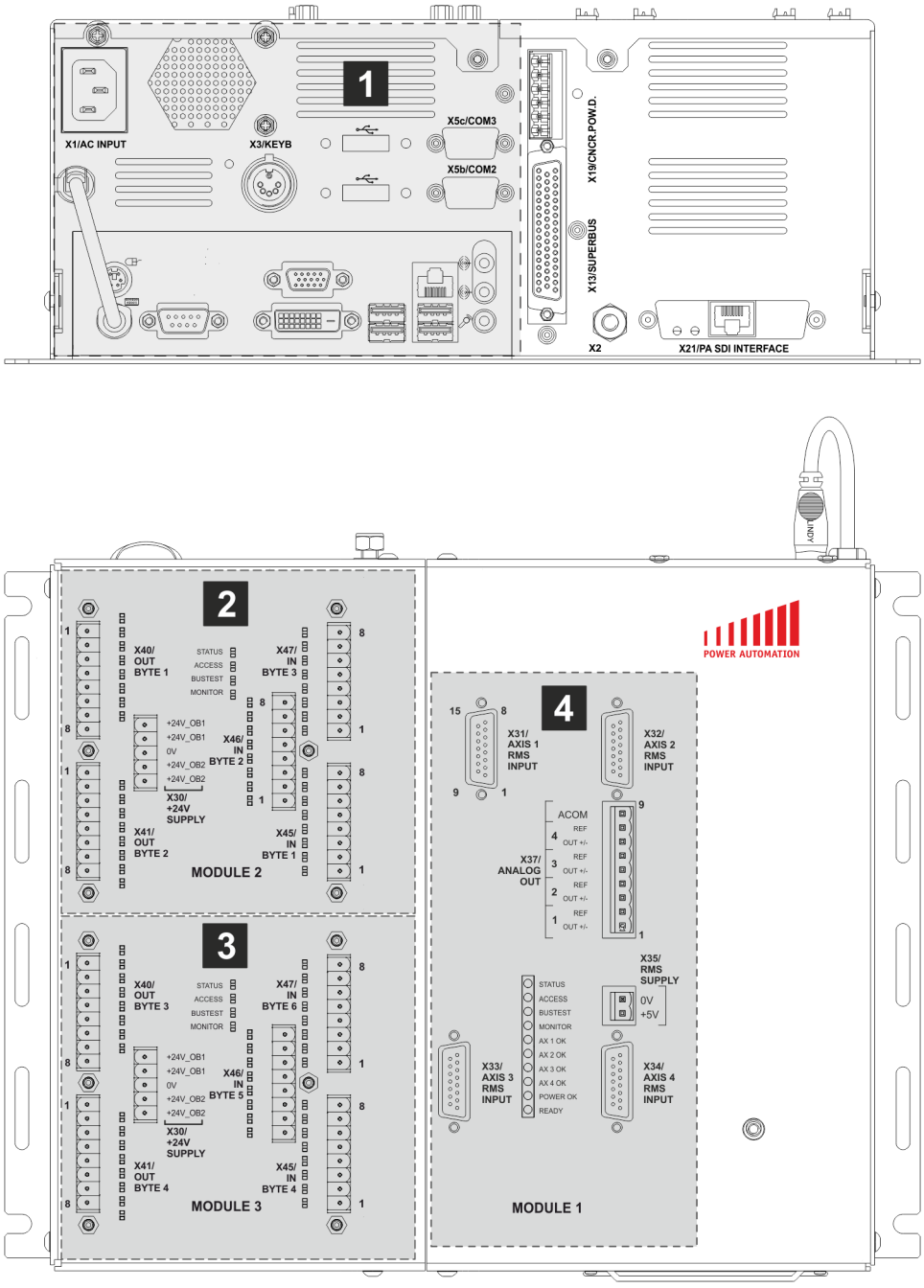


Fig. 4: Modules

1 PC connectors [all models]
2 Module 2416EL (1) [all models]
3 Module 2416EL (2) [all models]
4 Module 4AXLX [models with analog axes only]

Model Configurations

The PA 8000 LW is shipped in three different models containing the following modules and interfaces.

Model	Description	PC con-nectors	SDI	Module 2416EL	Module 4AXLX
PA 8000 LW SDI	SDI axes only	included	included	2 included	not included
PA 8000 LW AN	Analog axes only	included	not included	2 included	included
PA 8000 LW SDI-AN	SDI and analog axes	included	included	2 included	included

3.2 Brief description

The PA8000 LW is an open architecture CNC control unit providing a variety of interfaces to connect machine tools. This control unit can be extended via a superbus interface and external input/output modules (PAMIO) to connect a wide range of machine tools.

The Interfaces and modules included in this control unit upon delivery are listed in the following chapters.

3.3 Module 4AXLX

Overview

> ***Not included in all models***
> *This module and its interfaces are only included in models with analog axes.*

The module 4AXLX provides an analog interface for up to four axes, each provided with a separate RMS input. The module includes 4 status LEDs.

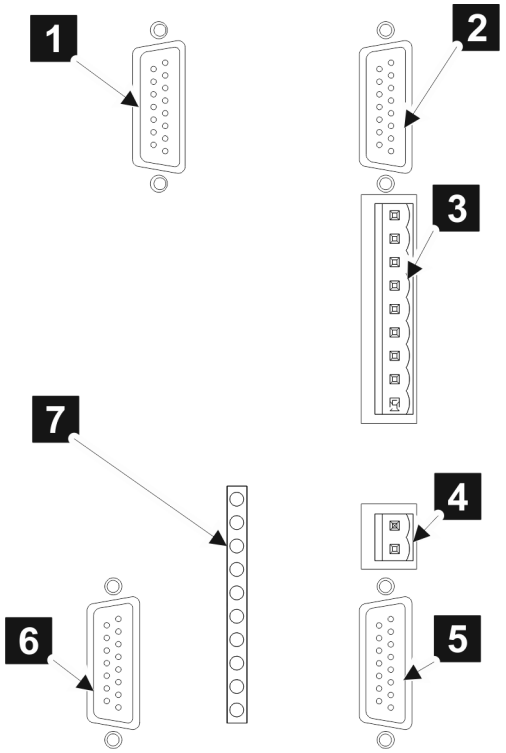


Fig. 5: Module 4AXLX

Pos.	Label No.	Function
1	X31	Measurement input 1. axis
2	X32	Measurement input 2. axis
3	X37	Analog out axis 1 to 4
4	X35	Power supply input for RMS encoders
5	X34	Measurement input 4. axis
6	X33	Measurement input 3. axis
7		Status LEDs

3.3.1 Digital Inputs

3.3.1.1 Input interfaces

Connectors

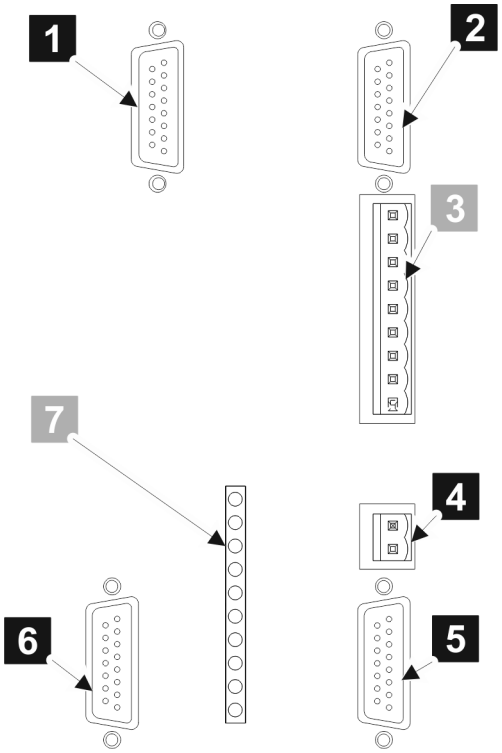


Fig. 6: Input interfaces

Pos.	Label No.	Function	Connector
1	X31	Connector 1st axis	15 pin, sub-D, female
2	X32	Connector 2nd axis	15 pin, sub-D, female
4	X35	RMS supply	2 pole connector
5	X33	Connector 3rd axis	15 pin, sub-D, female
6	X34	Connector 4th axis	15 pin, sub-D, female

Pin Assignment

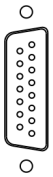


Fig. 7: Encoder input connector (X31/X32/X33/X34)

Pins (Fig. 7)	RMS Input Function
Pin 1	Track A+
Pin 2	Track A-
Pin 3	Track B+
Pin 4	Track B-
Pin 5	Track R+
Pin 6	Track R-
Pin 7	Probe input
Pin 8	Probe ground
Pin 9/11/13/15	Ground RMS
Pin 10/12/14	+5 V RMS

RMS Inputs

3.3.1.2 Input characteristics

Property	Value	Unit
Interface type	RS 422	
Track common mode range	-7 - +7	V
Max. track input voltage	-11 - +14	V
Min. track input voltage	+/- 500	mV
Track input impedance	150	Ω
Max. track frequency (no filter)	5	MHz
Max. count frequency (no filter)	20	MHz
External connector	15 pin Sub-D female / axis	

All signals on the RMS inputs are referenced against RMS ground.

Probe Inputs

Property	Value	Unit
Max. measurement input voltage	27	V
Measurement input current (at 24 V)	7	mA
Measurement input impedance	2200	Ω
Measurement operating voltage OFF	5	V DC max.
Measurement operating voltage ON	11	V DC min.
Measurement input ON delay	200	ns
Measurement input OFF delay	300	ns
Measurement isolation		Opto coupler
Interface type		digital input 24 V

Each measurement input is referenced against its measurement ground.

Probe wiring

When the RMS input is used in an application, each input of all used axes must be wired in parallel.

3.3.1.3 Input schematic

RMS Input Equivalent Schematic

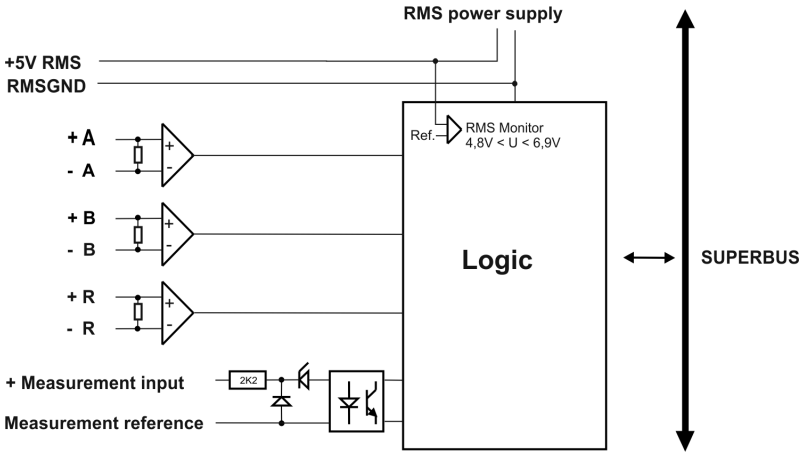


Fig. 8: RMS input equivalent schematic

3.3.1.4 RMS encoder wiring example

RMS Encoder Wiring Example

The following schematic demonstrates the recommended way of connecting the CNC RMS inputs to the encoders (or any other device with incremental output).

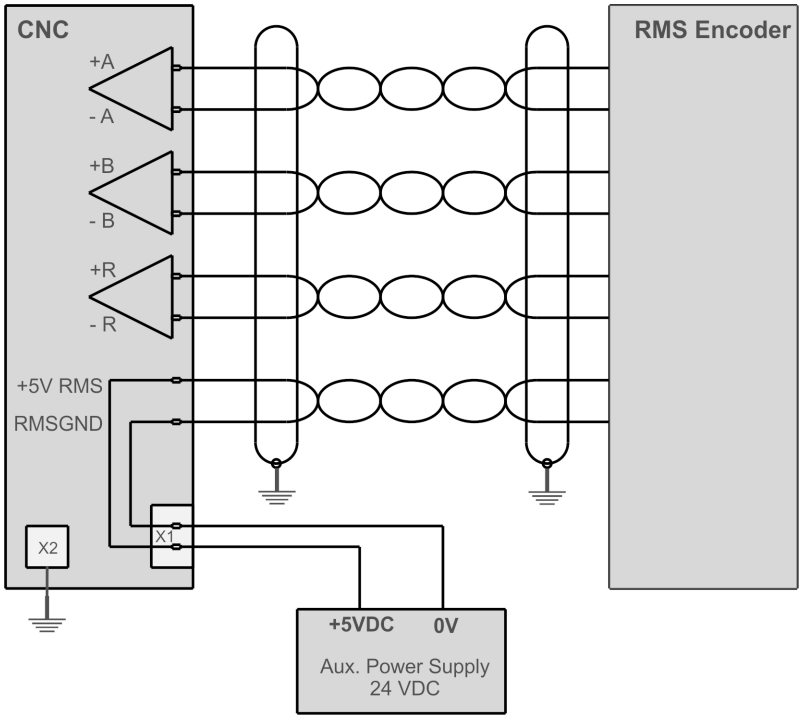


Fig. 9: RMS encoder wiring example

3.3.2 Digital Outputs

3.3.2.1 Output interfaces

Connection

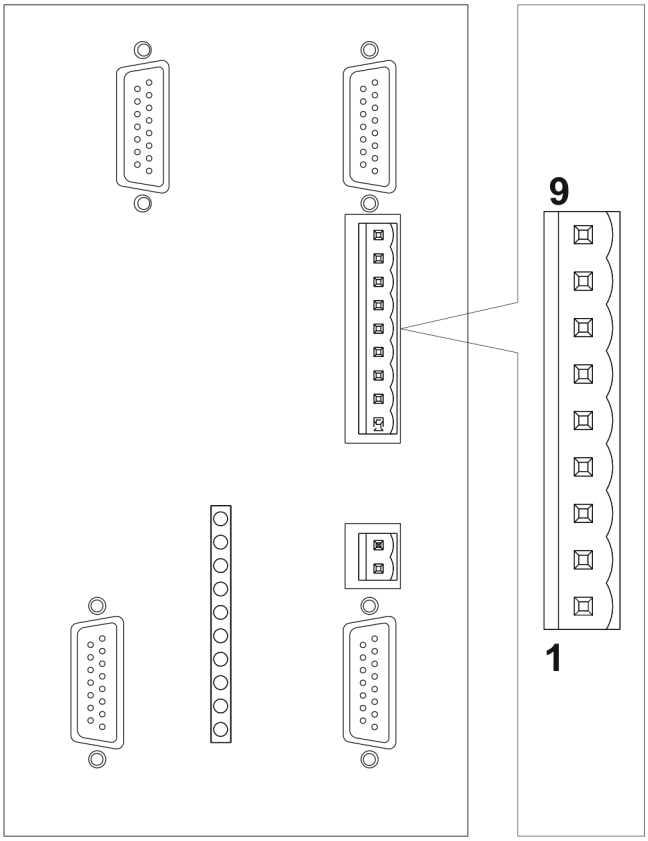


Fig. 10: Analog axes output connector

The signals of the four analog output channels are connected via a 9-pin connector (Fig. 10).

Each output channel has its own reference connection.

NOTICE!

Potential malfunctions of the control unit!

Different references of the channels have different voltage potential. Contact between the reference wiring may cause control unit malfunctions.

– Always connect reference wiring separately. Never tie reference wiring together.

Pin Assignment

Pins (Fig. 10)	RMS Input Function
Pin 1	+/- output channel 1
Pin 2	ground for channel 1
Pin 3	+/- output channel 2
Pin 4	ground for channel 2
Pin 5	+/- output channel 3
Pin 6	ground for channel 3
Pin 7	+/- output channel 4
Pin 8	ground for channel 4
Pin 9	analog ground (ACOM)

3.3.2.2 Output characteristics

Axes Output

Property	Value	Unit
Number of analog output channels	4	
Output signal range (max.)	+/- 10	V
Output current load (max.)	+/- 15	mA
Output capacitive load (max.)	350	pF
Bipolar zero error (max.)	+/- 40	mV
Full scale error (max.)	+/- 1	%
Channel to channel mismatch (max.)	+/- 1	%
Linearity error (max.)	+/- 2.44	mV
Resolution	305	µV
Conversion time (max.)	10	µ
Output slew rate	0.4	µV/s
Watchdog (max.)	64	ms
External connector	1 terminal block	

3.3.2.3 Output schematic

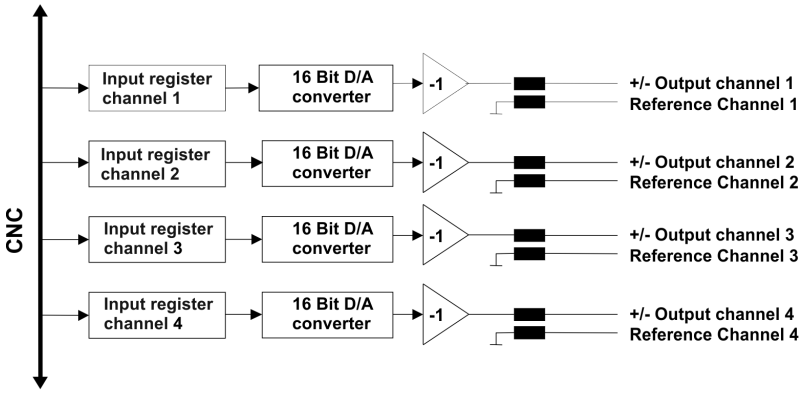


Fig. 11: Module 4AXLX analog output schematic

Analog output wiring

The wiring of the analog output to the drive depends on the type of drive analog inputs.

- *During drive installation check whether the drive analog inputs are grounded.*
- *If the analog inputs are grounded connect the drives according to the schematic for non differential inputs.*
- *If the analog inputs are not grounded connect the drives according to the schematic for differential inputs.*

3.3.2.4 Output Monitor

The functionality of the analog output to the drive is permanently monitored by the system. The real analog output signal is read-in and compared to fixed voltage level. Thus in case of defective digital/analog converter, the system can react and avoid machine damages.

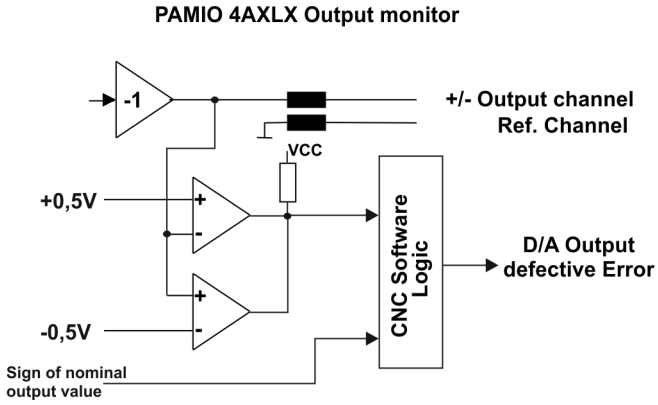


Fig. 12: 4AXLX output monitor

Analog output monitor

In case of errors, the system:

- *Deactivates the safety relay "CNC Ready" (refer &)*
- *Outputs an error message:*
  CNC 75 D/A output __ defective or missing
  where "__" indicates the number of the defective axis

CAUTION!

This monitoring is able to detect as well effective defectiveness of the digital/analog converter, but more frequently it detects noise or signal interference on the cable to the drives. Therefore:

- Check carefully the analog wiring between CNC and drive (refer &)!
- Disconnect the cable that goes to the drive, and check if the error still occurs
- Check machine parameter and Drive.cfg values related to this error monitoring

3.3.2.5 Analog axes wiring example

The following schematics demonstrate the recommended way of connecting the CNC analog outputs to the analog inputs of the drives, depending on the analog input type of the drive.

Drives With Non-Differential Inputs (Unipolar)

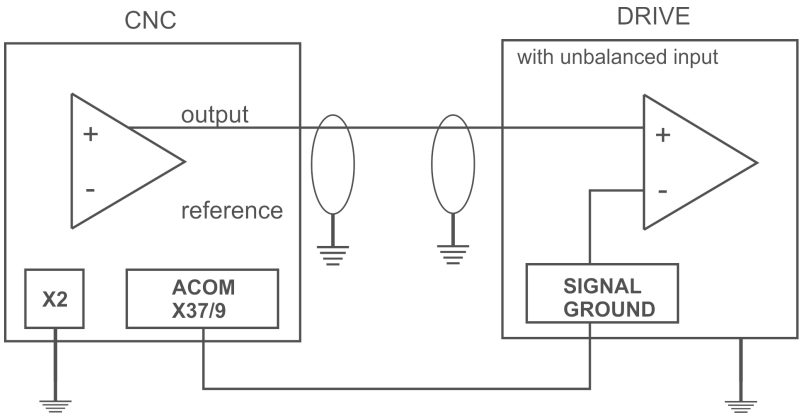


Fig. 13: Schematic non-differential inputs (unipolar)

Drives With Differential Inputs

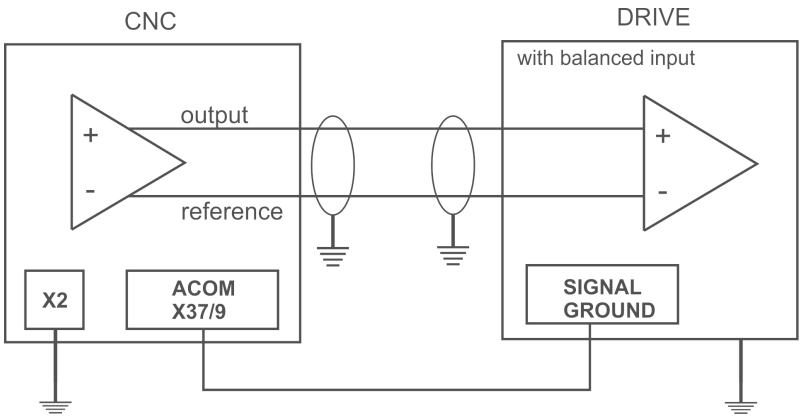


Fig. 14: Schematic differential inputs

3.3.3 RMS power supply

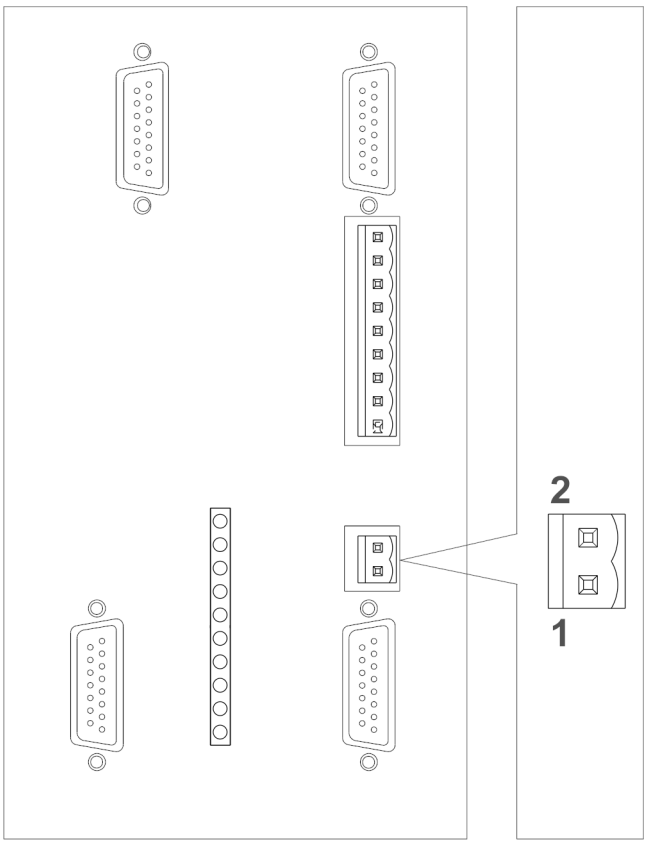


Fig. 15: RMS power supply connector (X35)

If required, the rotating measurement systems (RMS) can get their power from the module. The supply voltage, however, is not generated on the module but must be externally supplied via a 2 pole connector (X35 Fig. 15) on the 4AXLX module.

Pin Assignment

Pin (Fig. 15)	Voltage	Assignment
1	+5 V	RMS supply
2	0 V	RMS ground

Technical Data

Property	Value	Unit
Operating Voltage	5	V dc
Tolerance	-0 - +20	%

For further reference see *Chapter 5.3.3 “Setting up RMS supply voltage drop compensation” on page 92*.

3.3.4 Module 4AXLX LEDs

Overview

The 4AXLX module has ten LEDs for diagnostic purposes.

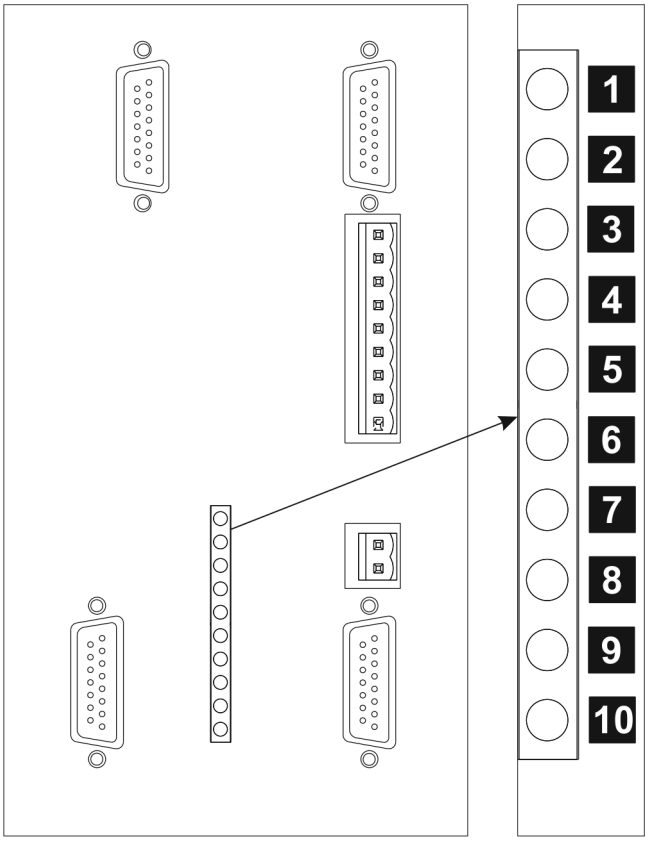


Fig. 16: Status LEDs

1 Status
2 Access
3 Bustest
4 Monitor
5 Axis 1
6 Axis 2
7 Axis 3
8 Axis 4
9 Power OK
10 CNC Ready

For a detailed assignment of the LEDs' states see *Chapter 8.2.1 “Module 4AXLX LEDs” on page 105*.

3.4 Module 2416 EL

The control unit has optionally one or two 2416 EL module(s). Each module has 24 digital inputs and 16 digital outputs (24V DC).

The inputs and outputs are fully opto-isolated from the internal logic.

Each module has its own monitoring system. The module status is displayed via 4 LEDs.

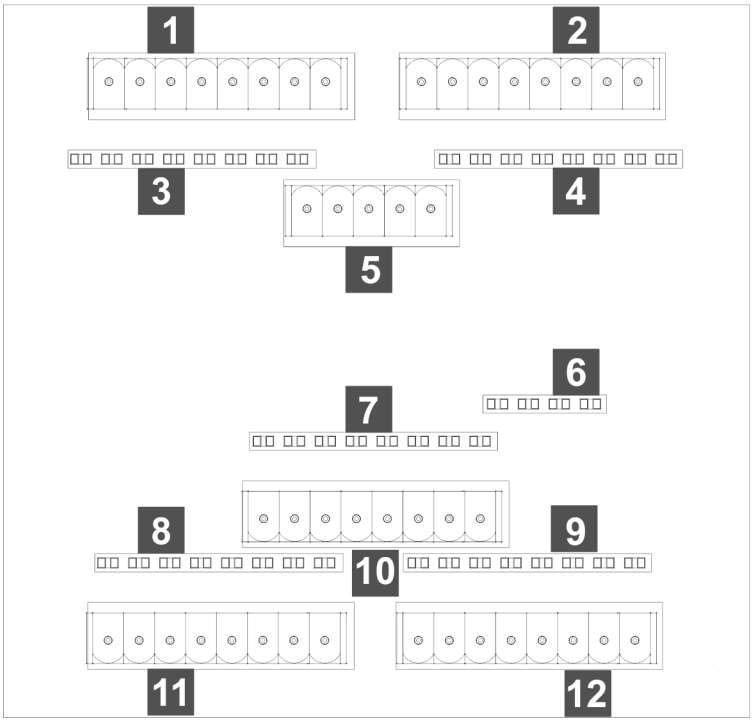


Fig. 17: Overview: connectors module 2416 EL

1 Output byte 2 (X41)
2 Output byte 1 (X40)
3 Status LEDs output byte 2
4 Status LEDs output byte 1
5 Power connector +24 V (X30)
6 Module status LEDs
7 Status LEDs input byte 2
8 Status LEDs input byte 1
9 Status LEDs input byte 3
10 Input byte 2 (X46)
11 Input byte 1 (X45)
12 Input byte 3 (X47)

3.4.1 Digital inputs

3.4.1.1 Input interfaces

Overview

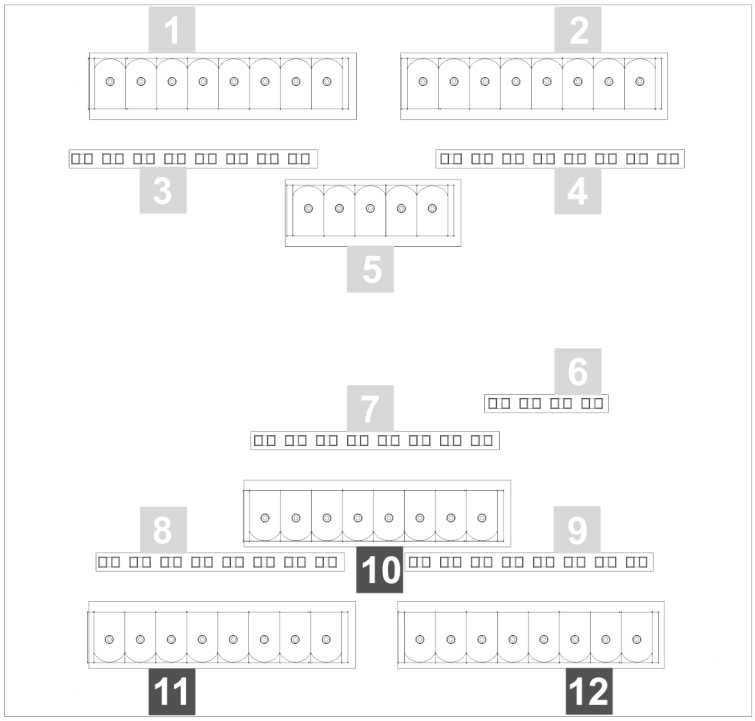


Fig. 18: Input bytes

10 Input byte 2 (X46)
11 Input byte 1 (X45)
12 Input byte 3 (X47)

The inputs are grouped in bytes (8 signals).

Connection

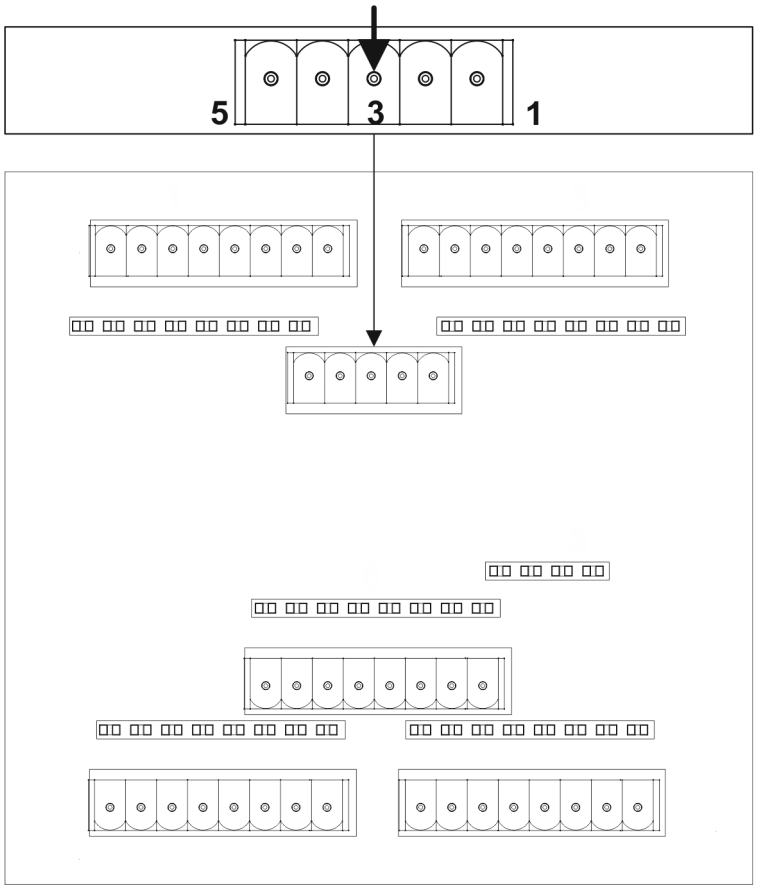


Fig. 19: Reference pin power connector

- Each byte is connected with an 8 pole terminal block.
- The conductor cross-section of the wire must be 0.3 to 1.75 mm^2 (AWG 22 to 15).
- The inputs are always referenced against the 0 V connector of the module (X30 pin 3 *“Connection” on page 41*).

Pin Assignment

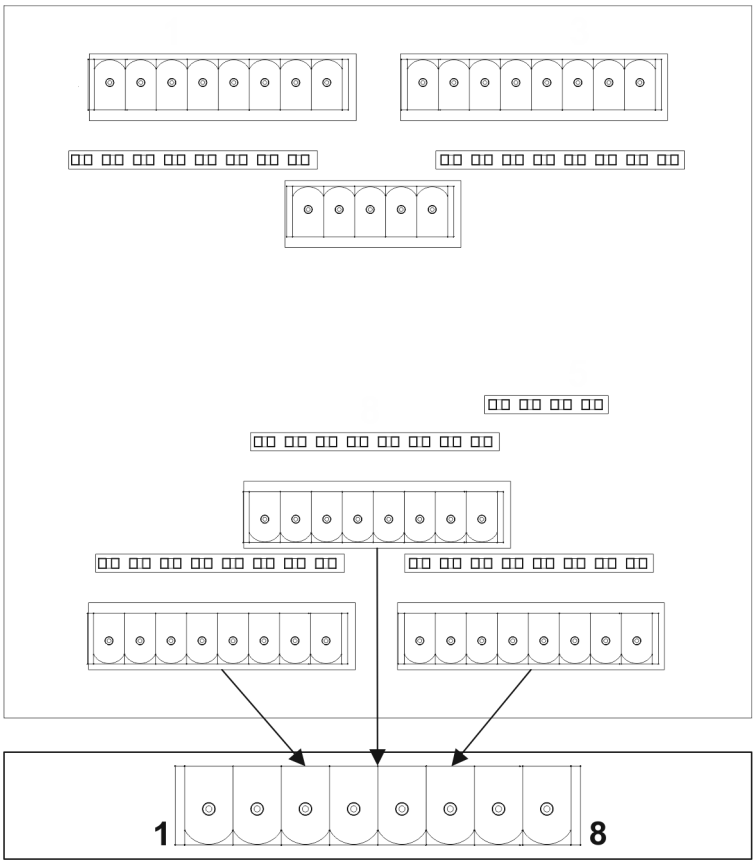


Fig. 20: Pin assignment

Byte 1	+24 V input	Byte 2	+24 V input	Byte 3	+24 V input
pin 1	1. input bit	pin 1	9. input bit	pin 1	17. input bit
pin 2	2. input bit	pin 2	10. input bit	pin 2	18. input bit
pin 3	3. input bit	pin 3	11. input bit	pin 3	19. input bit
pin 4	4. input bit	pin 4	12. input bit	pin 4	20. input bit
pin 5	5. input bit	pin 5	13. input bit	pin 5	21. input bit
pin 6	6. input bit	pin 6	14. input bit	pin 6	22. input bit
pin 7	7. input bit	pin 7	15. input bit	pin 7	23. input bit
pin 8	8. input bit	pin 8	16. input bit	pin 8	24. input bit

Input Status LEDs

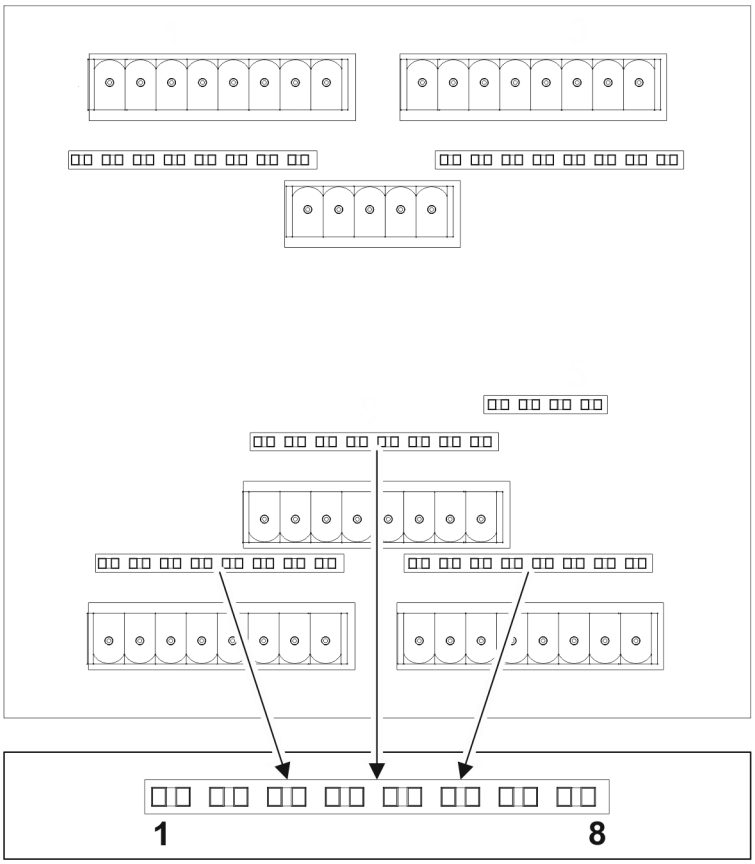


Fig. 21: Input status LEDs

The input LEDs are located in the circuit's input path and therefore show the real state of the 24 V inputs.

- A HIGH input signal causes the corresponding LED to turn ON.
- A LOW input signal causes the corresponding LED to turn OFF.

3.4.1.2 Input characteristics

Property	Value	Unit
Number of inputs	24	
Maximum input DC voltage	27	V
Input current at 24 V / 5 V (typical)	< 3	mA
Power dissipation at 24 V / 5 V per input	< 70	mW
Input impedance (24 V input)	10.5	kΩ
Input impedance (5 V input)	8.6	kΩ
operating DC voltage OFF (24 V input)	6	V max.
operating DC voltage ON (24 V input)	18	V min.
operating DC voltage OFF (5 V input)	1.2	V max.
operating DC voltage ON (5 V input)	2.5	V min.
Input ON delay	25	µs
Input OFF delay	65	µs
Isolation	by opto coupler	
Input ON display	LED	
External connection	1 terminal block for 8 inputs	

3.4.1.3 Input schematic

This figure shows how the inputs are realized on each 2416 EL module.

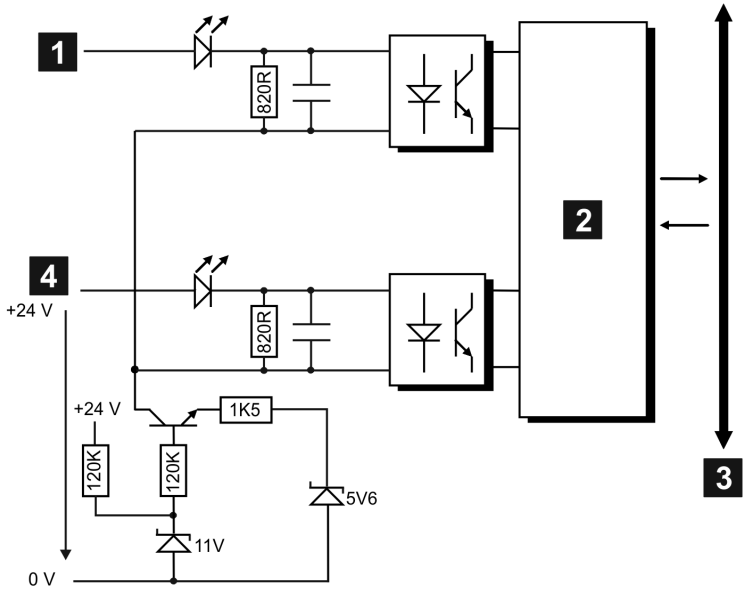


Fig. 22: Input equivalent schematic

1 Input n+1
2 Logic
3 CNC superbus
4 Input n

3.4.1.4 Handwheel I/O

On each 2416 EL input/output module two special inputs for handwheel connections are provided. The inputs are located on bit 23 and 24 of the third byte of each 2416 EL module. They are designed for 24 V encoder handwheels meeting the following specifications.

Special use of bits 23 and 24 of the 3rd input byte

When connecting handwheels to the described inputs only use 24 V encoder handwheels.

When no 24V handwheel is connected, the two inputs can be used in the same way as the other inputs of the 2416 EL module.

Required Handwheel Specifications

Property	Value	Unit
Supply level	24	V DC
Signal level	24	V DC
Encoder signals	Track 'A' and 'B' (shifted 90°)	

Only handwheels with A/B signals can be used. No 'Pulse/Direction' signals are supported.

Behavior

When these particular inputs are used for a handwheel, the software of the control unit will only read the value of a hardware fast counter implemented on the 2416 EL module which is counting the track signals. This avoids counting errors that could occur if the software was reading the tracks directly like standard I/Os.

Prerequisites for the described functionality of the handwheel inputs:

- control unit software revision above 2.3.8
- special machine parameter settings
  For further information refer to the machine parameter manual or machine parameter tool (MPTOOL) online help.

Wiring Schematic

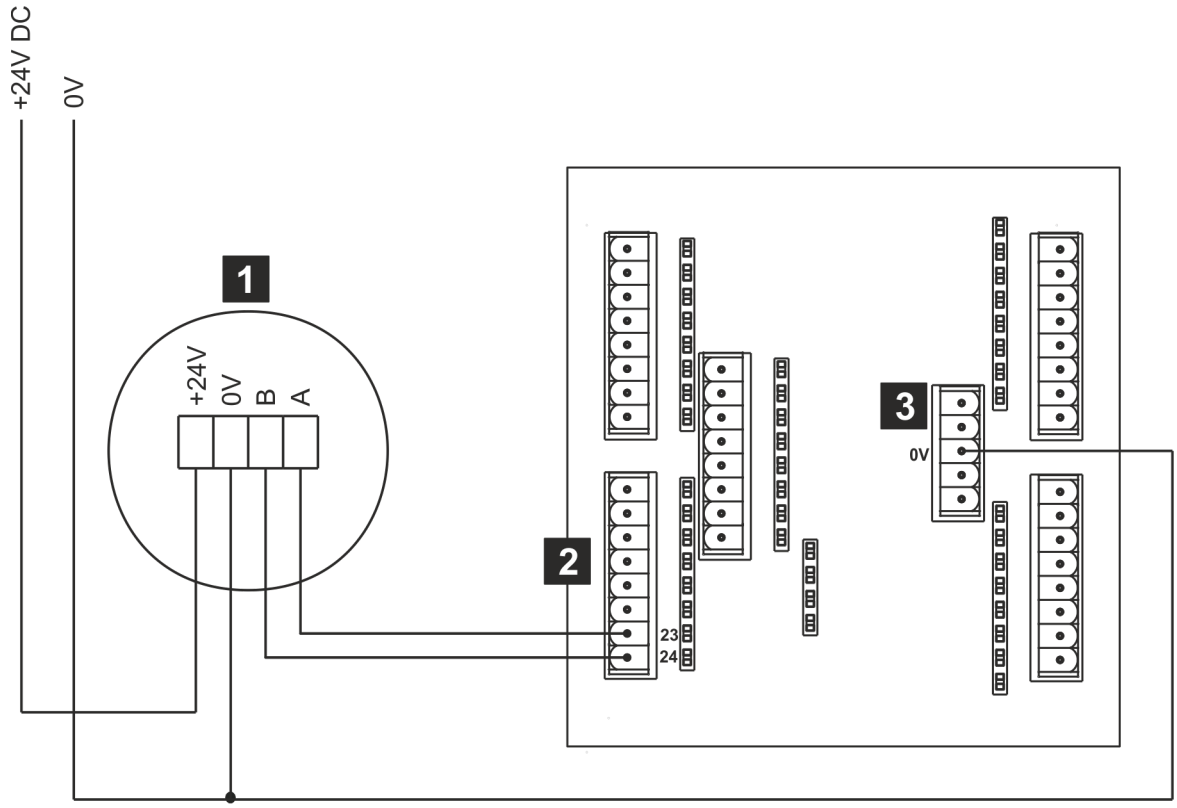


Fig. 23: Wiring schematic handwheel inputs

1 Handwheel
2 Input byte 3
3 Power supply connector

The ground of the power supply used for the handwheel must be connected to the one of the power supplies of the 2416 EL module (connector X30, pin 3).

3.4.2 Digital outputs

3.4.2.1 Output interfaces

Overview

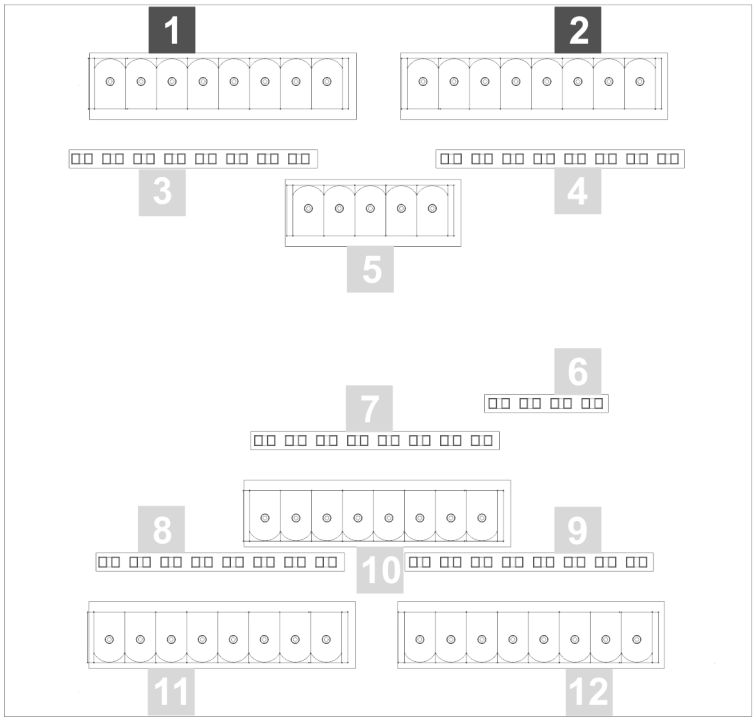


Fig. 24: Output bytes

2 Output byte 1 (X41)
1 Output byte 2 (X40)

The outputs are grouped in bytes (8 signals).

Connection

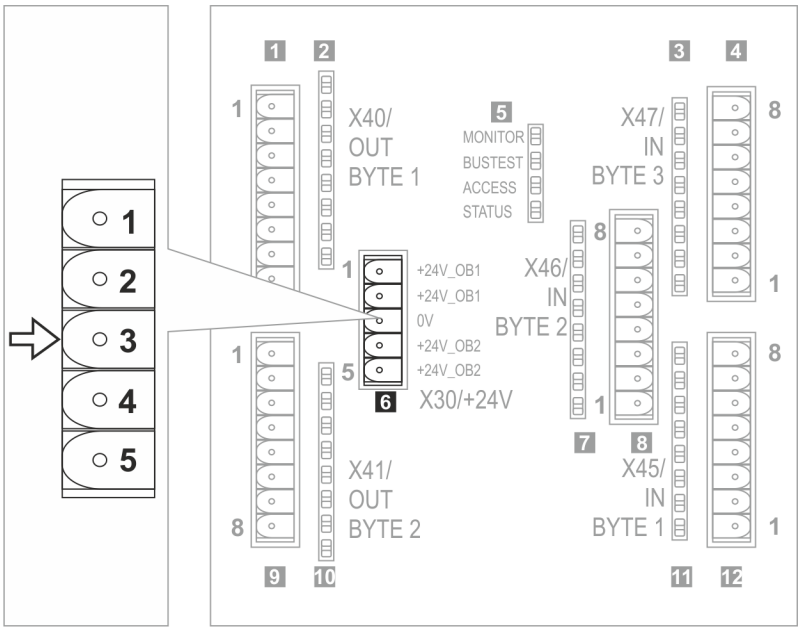


Fig. 25: Reference pin power connector

- Each byte is connected with an 8 pole terminal block.
- Each output byte has its own power supply connection. This feature can be used to turn off a whole byte using an external switch.
- The outputs are always referenced against 0 V, located in the power connector (X30 pin 3 Fig. 25).

The current limitation of each output is 0.7 - 2.5 A per pin in case of short circuits.

– *Consider that the power supply cable for one output byte has to be chosen accordingly.*

Each output has a nominal output capability of 1 A. Nevertheless each output byte (8 signals) is globally limited to 4 A.

– *Take care of this specification by appropriate output definition toward the external actuator.*

Outputs are monitored for faults. In case of errors, the output is switched off.

Since every 4 adjacent outputs have a common status signal, the onboard monitor always switches off 4 outputs in such a case (1 - 4, 5 - 8, 9 - 12, 13 - 16).

Pin Assignment

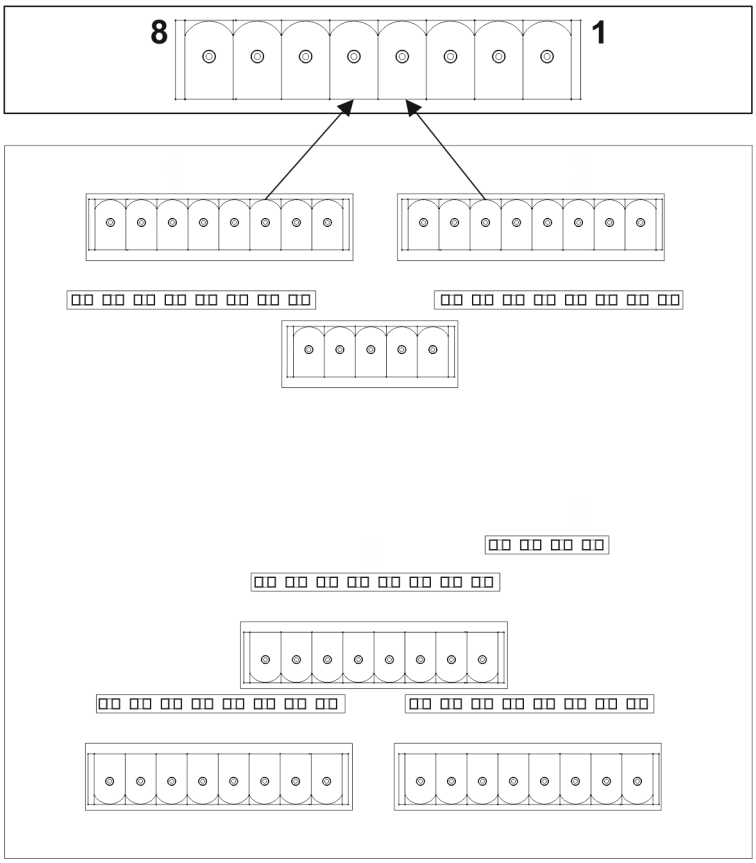


Fig. 26: Pin assignment

Byte 1	+24 V output	Byte 2	+24 V output
pin 1	1. output bit	pin 1	9. output bit
pin 2	2. output bit	pin 2	10. output bit
pin 3	3. output bit	pin 3	11. output bit
pin 4	4. output bit	pin 4	12. output bit
pin 5	5. output bit	pin 5	13. output bit
pin 6	6. output bit	pin 6	14. output bit
pin 7	7. output bit	pin 7	15. output bit
pin 8	8. output bit	pin 8	16. output bit

Output Status LEDs

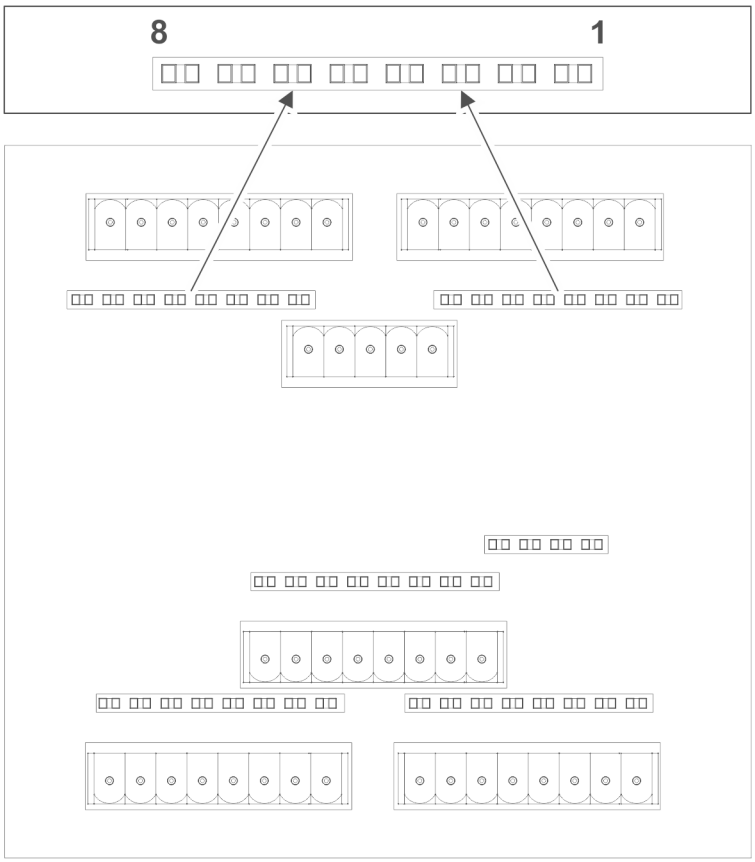


Fig. 27: Output status LEDs

The output LEDs are located directly in the output path and therefore show the real state of the 24 V outputs.

- If the outputs are ON, the corresponding LEDs are ON.
- If the outputs are OFF, the corresponding LEDs are OFF.
- In case of a short circuit, the output LED is OFF, even if the output is active.

3.4.2.2 Output characteristics

Property	Value	Unit
Number of outputs	16	
Max. continuous output DC per pin	1	A
Max. total continuous output current per byte	4	A
Power dissipation per pin at 24 V for 0.5 A	0.20	W
Power dissipation per pin at 24 V for 1.5 A	0.45	W
Output ON delay (typical)	100	µs
Output OFF delay (typical)	200	µs
Watchdog (max.)	64	ms
Short circuit output DC	0.7 - 2.5	A
Delay time current limitation (max.)	2	ms
Isolation	by opto coupler	
Output ON display	LED	
External connection	1 terminal block for 8 outputs	

All outputs are referenced against 0 V (power supply connector X30, pin 3).

3.4.2.3 Output schematic

This figure shows how the outputs are realized on each 2416 EL module.

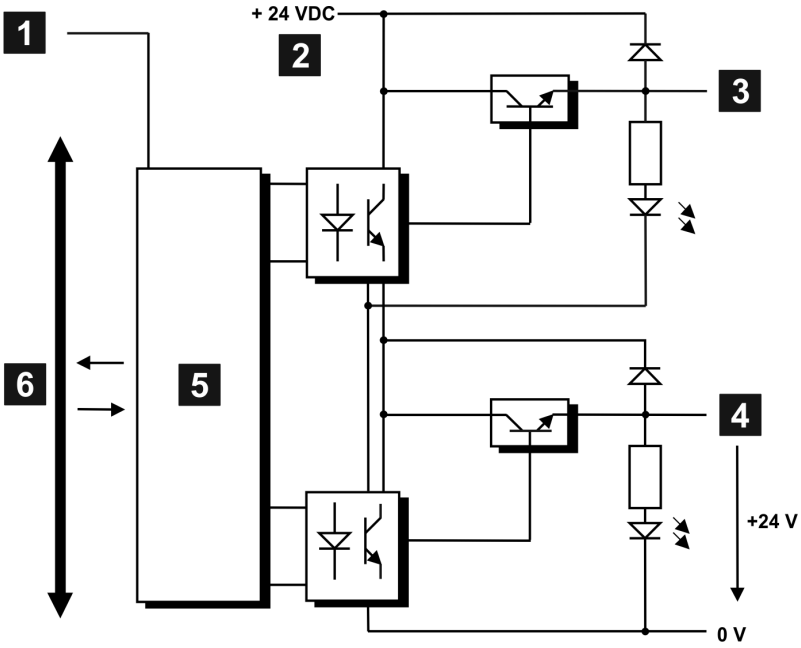


Fig. 28: Module 2416 EL output schematic

1 Supplied from PCI Superbus board
2 Output supply input (-15 % - +12.5 %)
3 Output n + 1
4 Output n
5 Logic
6 Internal serial bus

3.4.3 Power connection

Overview

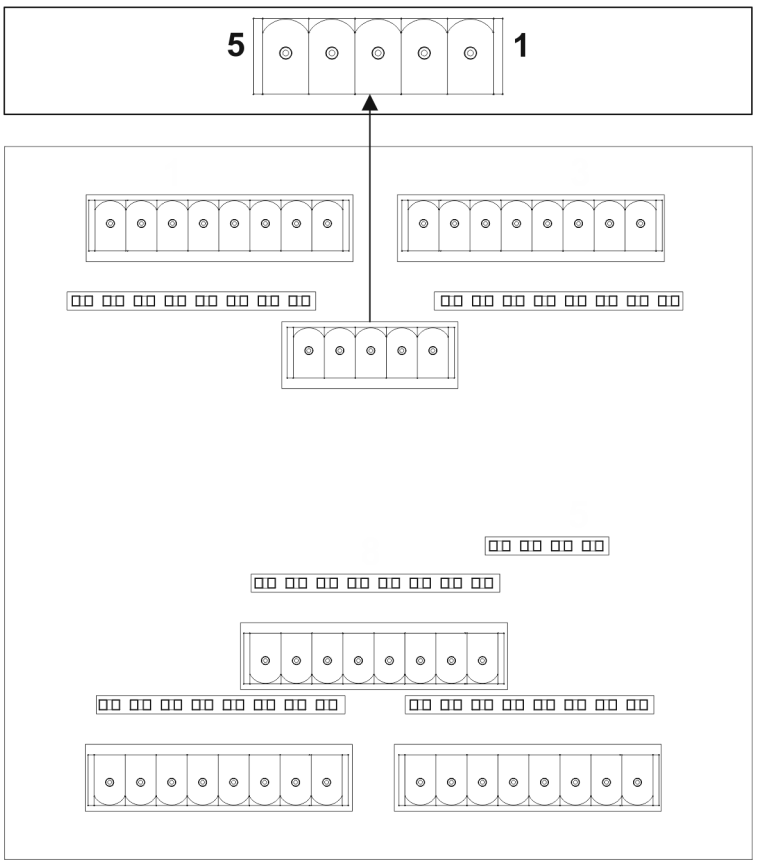


Fig. 29: Power supply connector + 24 V DC

Each of the 2416 EL modules needs a separate + 24 V DC power supply for its DC outputs (connector X30).

Pin Assignment

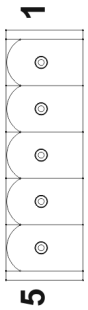


Fig. 30: Power supply pins

Each module has a 5 pin connector (X30) with the following pin assignment:

Pin (Fig. 30)	Assignment
Pin 1	+ 24 V power supply for output byte 1
Pin 2	+ 24 V power supply for output byte 1
Pin 3	0 V
Pin 4	+ 24 V power supply for output byte 2
Pin 5	+ 24 V power supply for output byte 2

Technical Data

Property	Value	Unit
Operating voltage	+24	V DC
Tolerance	-15.0/+12.5	%
Effective range	10.4 - 27.0	V
Current limitation	0.7 - 2.5	A
Reference	Pin 3 (0 V)	

Notes

- Pin 1 and 2 are connected internally.
- Pin 4 and 5 are connected internally.
- Reference for all is pin 3 (0 V).
- With pins 1 and/or 2 and pins 4 and/or 5 the output bytes are supplied separately. The two output bytes can be supplied independently from each other.
  This allows, for example, power to be supplied independently to each byte in case of an emergency stop.

For proper load balancing across pins, connections to all available pins per output byte are recommended.

– *Establish wire connections to both pins 1/2 and 3/4 respectively.*

The current limitation of each output is 0.7 - 2.5 A per pin in case of short circuits.

– *Consider that the power supply cable for each output byte has to be chosen accordingly.*

3.4.4 Module 2416 EL LEDs

Overview

The 2416 EL module has four LEDs for diagnostic purposes.

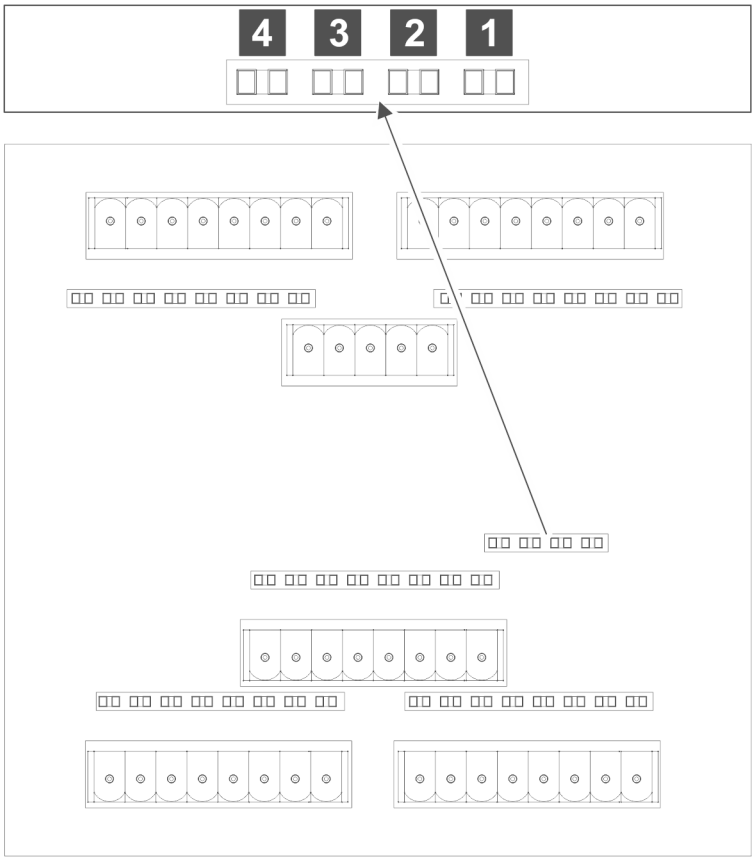


Fig. 31: Status LEDs

1 Status
2 Access
3 Bustest
4 Monitor

For a detailed assignment of the LEDs' states see *Chapter 8.2.2 “Module 2416 EL LEDs” on page 109*.

3.5 PC connectors

Overview

The control unit provides a number of standard PC interface connectors for various input and output applications (see Fig. 32).

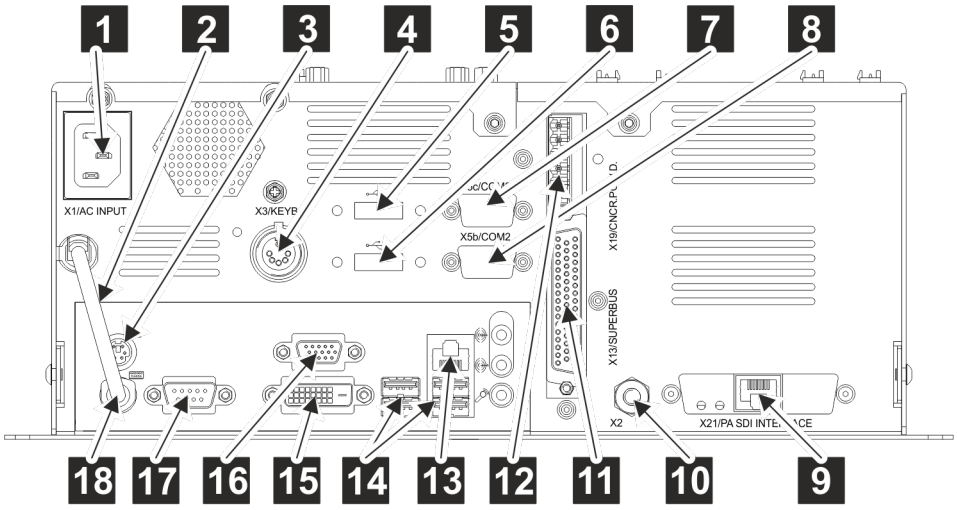


Fig. 32: Overview PC connectors

1 Main power supply (X1)
2 Operator's panel keyboard cable
3 PS2, 6 pin mini DIN, connector for mouse, female
4 Connector CNC operator's keyboard (X3)
5 USB 2.0 connectors (optional)
6 USB 2.0 connectors (optional)
7 Serial port connector, COM1, Sub-D 9 pin male (X5c)
8 Serial port connector, COM1, Sub-D 9 pin male (X5b)
9 PA SDI-Interface (X21)
10 Protective earth, ground screw (X2)
11 PAMIO Connector (X13)
12 Safety Connector (X19)
13 Ethernet connector RJ 45
14 USB 2.0 connectors
15 DVI Connector (X4)
16 VGA connector, Sub D 15 pin female (X4)
17 Serial port connector, COM1, Sub-D 9 pin male (X5a)
18 PS2, 6 pin mini DIN, connector for keyboard, female

Hardware configuration subject to change

Due to varying configurations of the mainboards produced by the suppliers, the number and positions of USB, serial and parallel ports may differ from the example provided in this installation manual.

– *For information on the applicable number of interfaces see the specification provided in the sales records.*

(X1) Main Power Supply (1)

- Always use the line cable delivered with the control unit.
- Ensure, that the line cable is only connected to either **115 V AC** or **230 V AC**.
- Ensure, that the power supply of the control unit is protected by an external fuse type **2A MDL (at 230 V AC)** or **4A MDL (at 115 V AC)**.

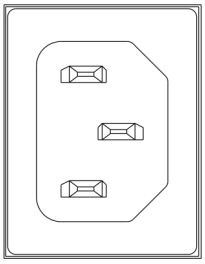


Fig. 33: Power supply connector

Power supply properties

Property	Value	Unit
Voltage	115 - 240	V AC
Tolerances	+10 / -15	%
Frequency	50 - 60	Hz
Maximum current (at 115 V)	4	A
Maximum current (at 230 V)	2	A
Maximum power consumption	180	W

NOTICE!

Damage to the control unit!

Supply voltages not supported can cause damage to the control unit.

(X3) CNC Operator's keyboard (4) (Optional)

The CNC operator's keyboard connector is intended for use with a PA operator's panel with keyboard. Alternatively a standard PC keyboard may be connected.

Supported panels:

- CP 121
- CP 121 T

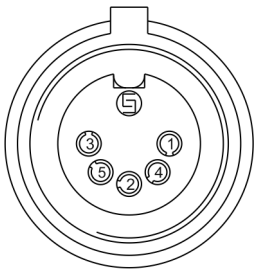


Fig. 34: Connector CNC operator's keyboard

Keyboard power supply

The listed operator's panels include their own keyboard controller, mounted on the rear side of the panel. This keyboard controller requires 12 V power supply. Therefore on pin 3 of the CNC keyboard connector an additional 12 V is supplied, unlike on standard keyboard connectors.

- Note that the connector is only compatible with the listed panels.

Pin (Fig. 32)	Assignment
1	keyboard clock
2	keyboard data
3	+ 12 V
4	GND
5	+ 5 V

Ethernet Connector (13)

The Ethernet connector allows connection of the control unit to local area networks.

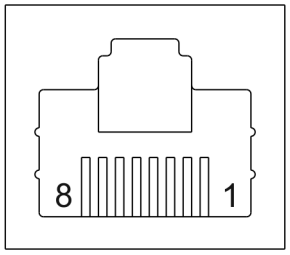


Fig. 35: Ethernet connector (RJ 45)

NOTICE!

Malfunctions and damage to the control unit!

The control unit provides two RJ 45 connectors. One is located on the PC interface panel (Fig. 32/13) and only intended for Ethernet connections. The other RJ 45 connector (Fig. 32/9) is located next to the PAMIO superbus connector. Inadvertent interchanging of the two connectors can cause control unit malfunctions and damages to the control unit and the attached drives.

- When setting up the wiring, carefully observe the connectors' positions given in this installation manual as well as the labels on the control unit.

Property	Value
Pins	8
Connector type	RJ 45
Max length	100 m (328 ft)

Pin (Fig. 32)	Ethernet 10/100 BaseT
1	TX+
2	TX-
3	RX+
4	
5	
6	RX-
7	
8	

(X2) Protective Earth, Ground Screw (10)

The protective ground screw (X2) provides a means to ensure grounding connection of the control unit.

Fig. 36: Ground screw

- Use the ground screw (M6) provided with the control unit.
- Use a wire of **6 mm²** (10 AWG) cross section at minimum.
- For standard conforming distinction use wire sheathed in yellow/green.

USB 2.0 Connectors (5, 6, 14)

The USB ports allow connection of USB peripherals. The control unit includes 3 standard USB 2.0 type A ports.

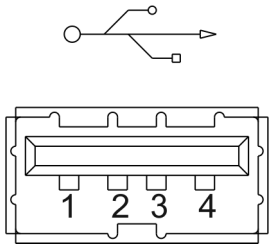


Fig. 37: USB connectors (Type A)

Property	Value
Pins	4
Connector type	USB 2.0 Type A
Max length	5 m (16.5 ft)

Pin (Fig. 32)	Assignment USB
1	VBUS
2	D-
3	D+
4	GND
Shell	Shield

(X4) VGA Connector (16)

The control unit is equipped with a VGA connector to connect graphic displays.

- Only use either with PA operator's panels or a standard VGA compatible monitor.

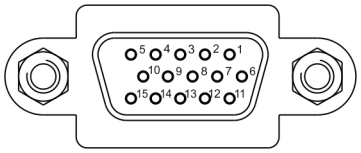


Fig. 38: VGA connector (Sub-D 15)

Property	Value
Pins	15
Connector type	sub D (high density)
Gender	female

Pin (Fig. 32)	Assignment
1	RED
2	GREEN
3	BLUE
4	not used
5	GND
6	RED GND
7	GREEN GND
8	BLUE GND
9	KEY
10	SYNC GND
11	Monitor ID 1
12	Monitor ID 2
13	HSYNC
14	VSYNC
15	not used

(X4) DVI Connector (15)

Digital Visual Interface (DVI) is a video display interface developed by the Digital Display Working Group (DDWG). The digital interface is used to connect a video source, such as a display controller to a display device, such as a computer monitor.

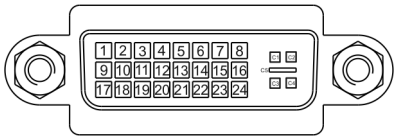


Fig. 39: DVI connector

Pin (Fig. 39)	Assignment
1	TMDS data 2−
2	TMDS data 2+
3	TMDS data 2/4 shield
4	TMDS data 4−
5	TMDS data 4+
6	Clock
7	Data
8	SYNC
9	TMDS data 1−
10	TMDS data 1+
11	TMDS data 1/3 shield
12	TMDS data 3−
13	TMDS data 3+
14	+5 V
15	GND
16	Hot plug detect
17	TMDS data 0−
18	TMDS data 0+
19	TMDS data 0/5 shield
20	TMDS data 5−
21	TMDS data 5+
22	TMDS clock shield
23	TMDS clock+
24	TMDS clock−

Pin (Fig. 39)	Assignment
C1	RED
C2	GREEN
C3	BLUE
C4	SYNC
C5	GND

(X5) Serial Port Connector (7,8,17)

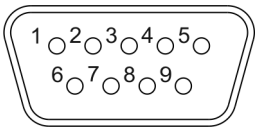


Fig. 40: Serial port connector (Sub-D 9)

Property	Value
Pins	9
Connector type	sub-D
Gender	male
Signal type	RS232
Maximum cable length	15 m (49 ")

Pin (Fig. 40)	Assignment
1	DCD (input)
2	RXD (input)
3	TXD (output)
4	DTR (output)
5	GND
6	DSR (input)
7	RTS (output)
8	CTS (input)
9	RI

The optional COM2 (X5b) and COM3 (X5c) have the same layout and the same characteristics as serial port COM1 (X5).

(X3) PS2 Connector For Keyboard (4)

The control unit is equipped with a PS2 connector that can be used for a standard keyboard connection.

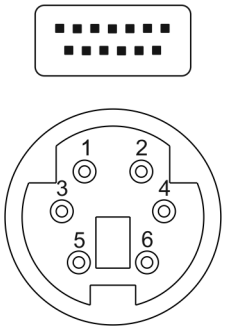


Fig. 41: Keyboard connector (PS2 mini)

Keyboard installation

This connector must be used when no operator's panel is installed.

This connector can be used to connect an additional secondary keyboard.

Connection of PA operator's panel

When connecting a PA operator's panel with keyboard, the following requirements have to be met:

- *Ensure, that the panel's keyboard is connected to the CNC operator's keyboard connector (Fig. 32 pos. 4).*
- *Ensure, that the built-in PA keyboard cable (Fig. 32 pos. 2) is connected to this PS2 connector (Fig. 32 pos. 18).*

Supported panels

- CP 121
- CP 121 T

Property	Value
Pins	6
Connector type	PS2 mini DIN
Gender	female

Pin (Fig. 32)	Assignment
1	data
2	
3	GND
4	power supply +5V
5	clock
6	

PS2 Connector For Mouse (3)

The control unit is equipped with a PS2 connector that can be used for a standard mouse connection.

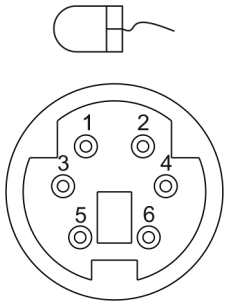


Fig. 42: Mouse connector (PS2 mini)

Property	Value
Pins	6
Connector type	PS2 mini DIN
Gender	female

Pin (Fig. 32)	Assignment
1	data
2	
3	GND
4	power supply + 5V
5	clock
6	

3.6 Safety connector

Overview

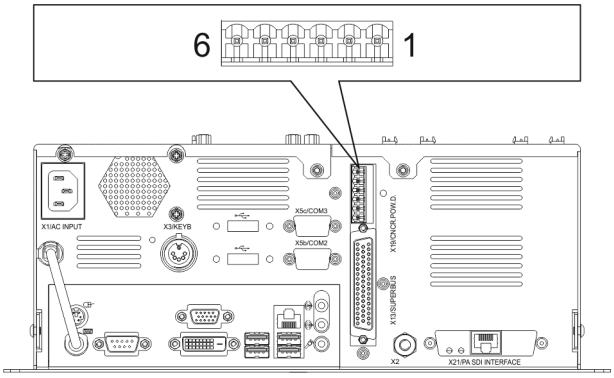


Fig. 43: X19 Safety Connector

All PA 8000 LW models have two relays for safety functions (connector X19) (see *“Overview” on page 58* pos. 12).

The connector provides both a normally closed and a normally open contact for each relay.

Purpose / Wiring

For information regarding the safety connector's purpose and wiring examples see *Chapter 2.8 “Machine safety” on page 17* and *Chapter 5.5 “Wiring for machine safety” on page 96*.

3.6.1 Safety connector specification

Specification

Property	Value
Form factor	6 pin, removable screw plug
Maximum contact load	1A / 24V DC

Pin Assignment

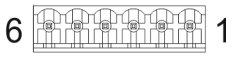


Fig. 44: Safety connector pins

Pin (Fig. 44)	Assignment
1	Power ok, common
2	Power ok, normally closed
3	Power ok, normally open
4	CNC ready, common
5	CNC ready, normally closed
6	CNC ready, normally open

Relay 1 "Power ok"

The first relay is called "Power ok" and switches when the following conditions are met:

- The power supply voltages are in operating range.
- The operating temperature is below +60 °C (+140 °F)

Logic	Condition	Result
	+ 5 V OK	Ready relay active
AND	+ 12 V OK	
AND	- 12 V OK	
AND	T < 60 °C (140 °F)	

NOTICE!

Damage to the control unit!

Voltage faults and/or temperatures above the allowed specification can cause damage to the control unit.

Properly wire the "Power ok" relay to protect the control unit from damaging voltages and temperatures.

Relay 2 "CNC ready"

The second relay is called "CNC ready" and switches when the following conditions are met:

- The control unit is ready when:
  - The watchdog is re-triggered.
    The software is monitored and works properly.
  - All encoder signals of the axes are correct.
  - All axes position loops are under control.
- The RMS power supply voltage is within operation range.
- The operating temperature is below +55°C (+131°F).

Logic	Condition	Result
	+ 5 V RMS OK	Ready relay active
AND	Control unit ready	
AND	T < 55 °C (131 °F)	

NOTICE!

Damage to the machine!

If the "CNC ready" relay is not wired properly to the machine's emergency stop circuit, the machine may be damaged upon operation.

- Ensure that the "CNC ready" relay is wired properly to the machine's emergency stop circuit.

3.6.2 Safety connector schematic

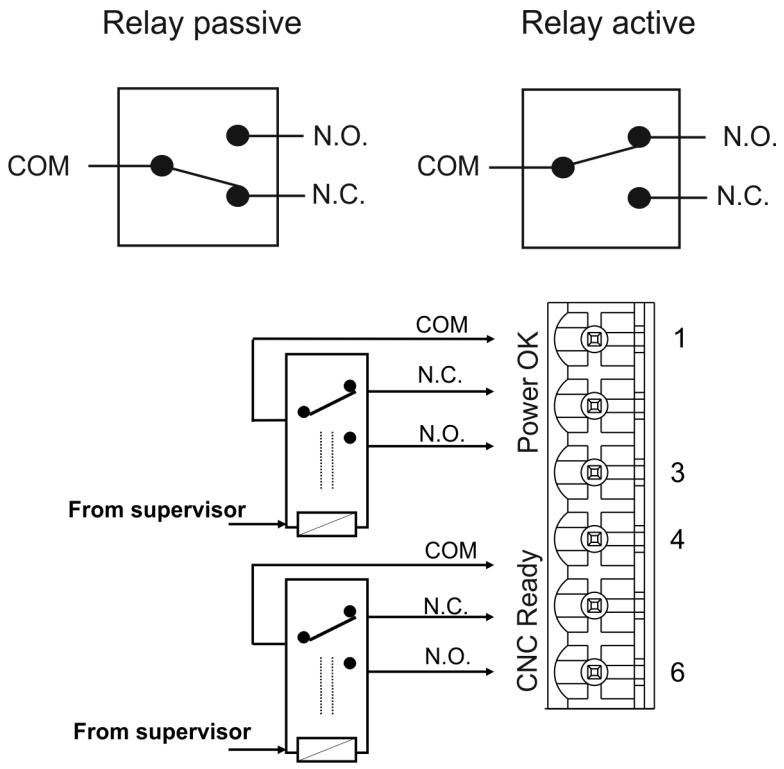


Fig. 45: Safety connector equivalent schematic

3.7 (X20) PA USB software dongle connector

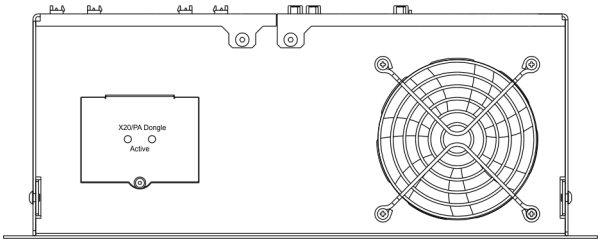


Fig. 46: PA USB software dongle connector

An additional USB port is specially marked as "PA dongle X20 port". It is located on the bottom side of the control unit. If the PA dongle is not connected to this port the PA software will not recognize the dongle and in consequence will not start.

- Always use the specially marked port to connect the PA USB software dongle.

3.8 PAMIO interface (superbus)

Overview

The control unit's interfaces are extendable via the Superbus interface. A variety of I/O and axes extension modules (PAMIO) can be connected to the connector.

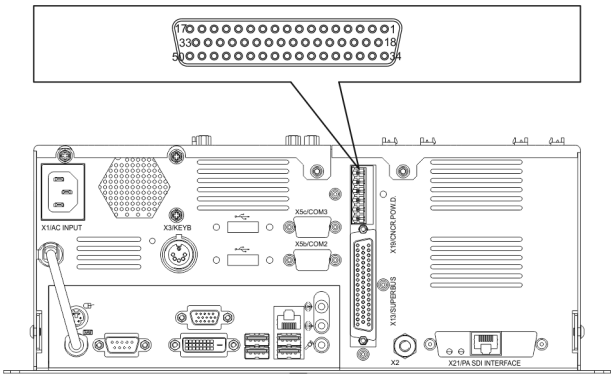


Fig. 47: Superbus Connector

For further information see *Chapter 3.8.1 “PAMIO boxes and modules” on page 73* or the PA Accessories installation manual.

Cable Specification

The interface cable required to connect PAMIO modules can be ordered from Power Automation.

NOTICE!
All cables connected to the control unit are intended for stationary use only.

The cable shield is connected to both connector casings.

Basic Description

3.8.1 PAMIO boxes and modules

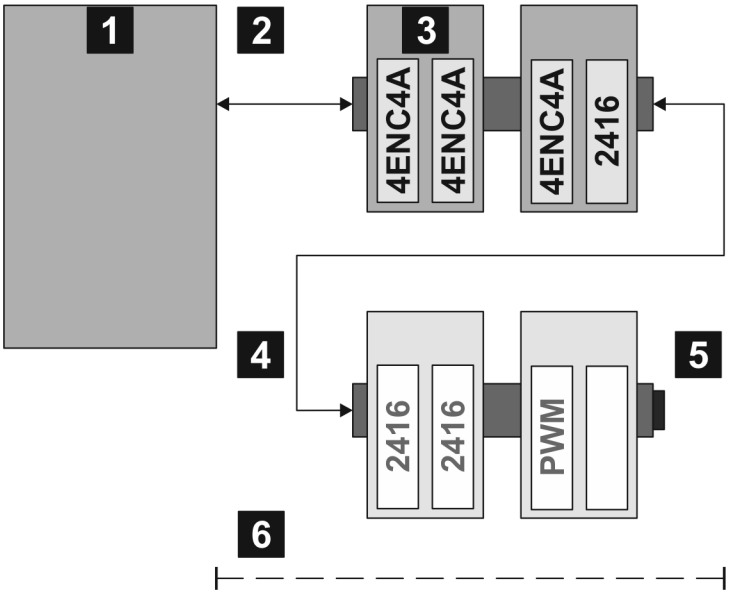


Fig. 48: PAMIO superbus schematic

1 control unit
2 PA superbus connection
3 PAMIO box with two analog axes modules
4 PA superbus connection
5 termination plug
6 max. chain length (14 PAMIO boxes/30 m (98 ft))

A PAMIO box consists of its housing, the PA superbus input and output connectors as well as two plug-in-slots for I/O modules. PAMIO boxes can be snapped onto DIN rails and plugged into each other side by side or connected through optional cables. The last box carries a termination plug.

Limited cable length

The limits for the I/O system are 31 I/O modules (1 internal 4AXLX module, 2 internal 2416EL modules plus a maximum of 14 PAMIO boxes).

The maximum cable length from the control unit to the last PAMIO box cannot exceed 30 m (98 ft). This has to be considered as a maximum global length when several PAMIO boxes are placed at different locations and connected with interconnection cables.

I/O modules can be mounted where needed, without requiring bus couplers. Each PAMIO module has its own watchdog timer for the PA superbus, temperature and voltage monitoring as well as corresponding LED displays on the front side.

Scope of delivery (control unit)

The PAMIO modules listed below are not included in the control unit's basic scope of delivery. They can be ordered from Power Automation (see ↳ Chapter 9 “Service and return process” on page 113).

For further information on the modules' specifications refer to the PA Accessories installation manual.

PAMIO Hardware

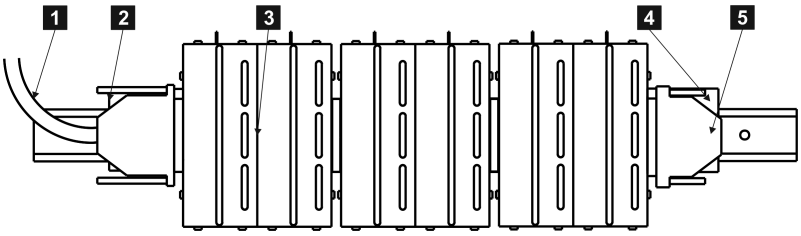


Fig. 49: PAMIO hardware

1 connection cable (30 m / 98 ft max.)
2 lateral rail stoppers
3 module box
4 stopping bracket
5 termination plug

Scope of delivery (PAMIO hardware)

PAMIO boxes are shipped without connection cables.

Cables of the following lengths can be ordered from Power Automation: 2 m (6.5 ft), 5 m (16.5 ft), 10 m (33 ft), 20 m (66 ft), 25 m (82 ft) (see ↳ Chapter 9 “Service and return process” on page 113).

Cable length

– *Ensure, that the total cable length between the control unit and the last PAMIO box does not exceed 25 m (82 ft).*

The PAMIO hardware consists of the following components:

- PAMIO boxes
- PAMIO modules (2 per box, options listed below)
- cable between control unit and PAMIO box
- termination plug
  (always required)
- lateral rail stoppers
  (required if more than one module box is used on the same rail)
- slot cover
  (required when a module slot is not occupied by a PAMIO module)

PAMIO 2416

Feature	Value	Specifications
digital inputs	24 (3 bytes)	24 V DC
digital outputs	16 (2 bytes)	24 V DC
isolation	optical	

PAMIO 4ENC4A

Feature	Value	Specifications
encoder inputs	4	
analog inputs	4	+/- 10 V (12 bit)
analog outputs	4	+/- 10 V (16 bit)

PAMIO 2ENC4A

Feature	Value	Specifications
encoder inputs	2	
analog inputs	4	+/- 10 V (10 bit)
analog outputs	4	+/- 10 V (16 bit)
termination plug	integrated	

PAMIO PWM

Feature	Value	Specifications
digital outputs	2	24 V DC

Characteristics

The main characteristics for the digital inputs and outputs of the PAMIO 2416 are similar to the ones of the integrated 2416EL modules (see *Chapter 3.4 “Module 2416 EL” on page 39*).

Likewise the characteristics of the measuring systems inputs and of the analog outputs of the PAMIO 4ENC4A are similar to the ones of the integrated 4AXLX modules (see *Chapter 3.3 “Module 4AXLX” on page 27*).

For detailed information about PAMIO modules, their installation and electric requirements refer to the PA Accessories installation manual.

4 Technical data

4.1 General specifications

General Information

Property	Value	Unit
Dimensions (WxDxH)	332.2 x 125 x 257	mm
	13.12 x 4.92 x 10.12	inch
Weight	6.2	kg
	13.7	lb

4.2 Connection values

Electrical

Property	Value	Unit
Input voltage	115 - 240	V AC
Tolerance	+10 / -15	%
Frequency	50 - 60	Hz
Maximum current (at 115 V)	4	A
Maximum current (at 240 V)	2	A
Maximum power consumption	180	W

4.3 Operating conditions

General

Property	Value	Unit
Operating temperature	+5 - +45	°C
	+41 - +113	°F
Storage temperature	-20 - +60	°C
	-4 - +140	°F
Temperature gradient (within 10 minutes)	10	°C
	50	°F
Relative humidity (non-condensing)	80	%
Maximum acceleration (non-operating)	4.0	G
Maximum acceleration (operating)	3.5	G
Protection class (EN 60529)	IP20	

NOTICE!

Functional defects!

The module casing does not provide sufficient protection against environmental influences. Dust and moisture may cause malfunctions.

– Only operate the control unit inside a cabinet that complies with the requirements as listed in the technical data (see *Table on page 86*).

4.4 Dimension sheet

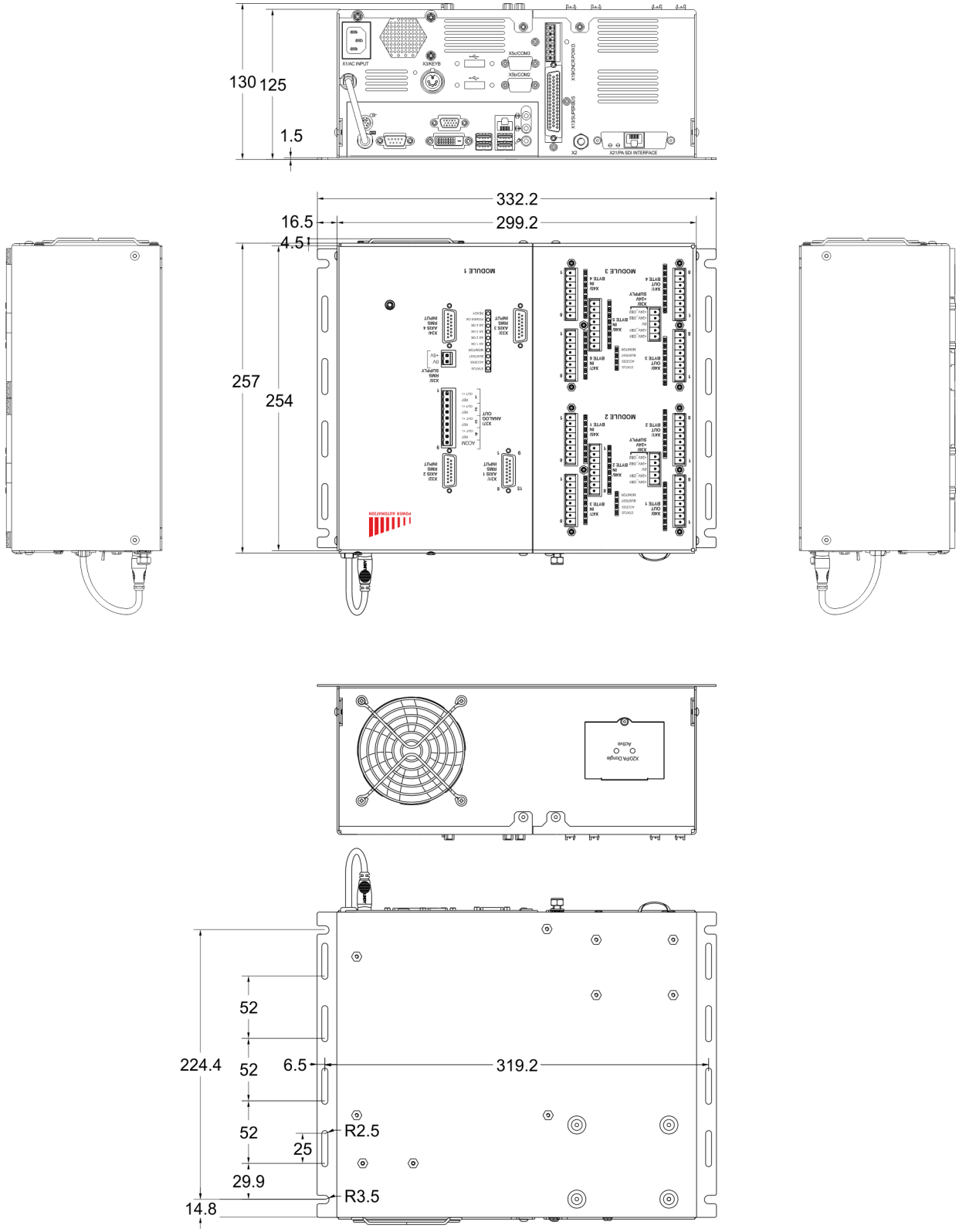


Fig. 50: dimension sheet

4.5 Electromagnetic compatibility

The control unit meets the requirements specified in the following standards:

Safety Of Machinery

Standard	Title	Requirement	Value
EN 60204-1 (VDE 0113-1)	Electrical equipment of machines	all met	-

Emitted Interference

Standard	Title	Requirement	Value
EN 55011:2009 + A1: 2010	Limits [...] of radio disturbance characteristics	interference voltage	class B
EN 55022:2006 + A1: 2007		interfering field strength	class B
EN 61000-6-3:2011	Generic standards - Emission standard for residential, commercial and light-industrial environments	emitted interference	class B

Interference Resistance

Standard	Title	Requirement	Value
IEC / EN 61000-6-2	[...] Immunity standard for industrial environments		
EN 61000-4-2	[...] Electrostatic discharge immunity [...]	ESD air discharge	8 KV
		contact discharge	4 KV
EN 61000-4-3	[...] Radiated, radio-frequency, electromagnetic field immunity [...]	HF irradiation 80..1000 MHz	10 V/m
EN 61000-4-4	[...] Electrical fast transient/burst immunity [...]	power line burst	2 KV
		signal data line burst	1 KV
EN 61000-4-5	[...] Surge immunity [...]	symmetric	1 KV
		asymmetric	2 KV
EN 61000-4-6	[...] Conducted disturbances immunity [...]	HF power input into the net, signal/data line	10 V
EN 61000-4-8	[...] Magnetic field immunity [...]	magnetic field 50 Hz	30 A/m
EN 61000-4-11	[...] Voltage variations [...]	voltage drops and interrupts	

Net Overtones

Standard	Title	Requirement	Value
EN 61000-3-2: 2006	[...] Limits for harmonic current emissions	all met	-
EN 61000-3-3:2008			

4.6 Installation guidelines

Meaning Of EMC

Electromagnetic compatibility (EMC) refers to the ability of an electrical device to work flawlessly in an electromagnetic environment without generating or being susceptible to disturbances. All **PA Control units** are designed for use in industrial environments and meet high EMC specifications.

Important Rules For EMC

Cabling

- The cabling must be in line groups (high voltage, current supply, signal and data lines)
- High voltage lines and signal respectively data lines must be laid in separate channels or bundles
- The signal and data lines have to be routed as near as possible beside ground areas

Reference potential and ground of all electrical operating supplies

- Installation parts and cabinets with your CNC control unit have to be connected in star topology with the isolation/protected ground conductor system to avoid ground loops.
- Sufficiently dimensioned potential compensation lines have to be laid if there are potential differences between installation parts and cabinets

Area-wide grounding of the inactive metal parts

- A central connection between the ground and the protected ground conductor system have to be installed.
- All inactive metals have to be connected extensively and impedance-low.

Fixing of the cable shield

- Data cables and analog cables must be laid separately from each other.
- The cable shield has to be laid extensively on a protected ground conductor rail directly after the cabinet entry and the fixation of the shield with cable clamps.
- The isolation / protected ground rail has to be connected impedance-low with the cabinet.
- The metallic or metallized plug cases for shielded cables must be used.
- When transmitting signals with small amplitudes the one sided grounding of the cable shield may be favorable.

Possible Interferences

Electromagnetic interferences may interfere with the control unit:

- Electromagnetic fields (RF coupling)
- Magnetic fields with power frequency
- Power supply
- Protected ground conductor
- Superbus system

Depending on the spreading medium and the distance to the interference cause, interferences to the control unit occur by means of capacitive, galvanic, inductive or radiant coupling mechanisms.

Shielding Of Conductors

Electrical, magnetic and electromagnetic interference fields are weakened by means of shielding

Via the shielding rail, which is connected with low impedance to the rack, interference currents are shorted by the cable shield to the ground. It's important that the connection to the protected ground conductor is impedance-low, because otherwise the interference currents may cause interference.

For the use of shielded cables the following rules are important:

- The screen cover should be higher than 80%
- The cables have a copper braid (shield / screen)
- Normally the cable shield must be connected to ground in both sides of the cable. Double-sided grounding is necessary to achieve high-quality interference suppression in the higher frequency range. The cable shield can be connected to single-sided grounding in exceptional cases, but if that is done, only lower frequencies will be absorped.

  A single-sided ground connection of the cable shield may be convenient, if:
  - the conduction of a potential compensating line is not possible
  - analog signals (some mV respectively µA) are transferred
  - foil screens (static screens) are used instead of screens made of copper braid.
- When using data lines always use metallic or metallized plugs for serial couplings. Fix the cable screen of the data line at the plug rack.
- It is convenient to strip the insulated cable interruption free and lay it on the isolation/protected ground conductor line (stationary operation).
- Metal cable clamps to fix the cable shield have to be used. The clamps must clasp the copper braid extensively and have good contact.
- The cable shield has to be laid on a protective earth rail directly after the entry of the cable in the cabinet. Do not attach the cable shield again on the CNC control / PAMIO device.

CAUTION!

Please observe at installation!

At potential differences between the grounding points, there may be a compensation current via the cable shield grounded at both sides.

5 Installation

Safety

WARNING!

Danger of injury due to improper installation and commissioning!

Improper installation and commissioning can result in severe personal injury or material damage.

- Prior to beginning installation, ensure that there is sufficient space to work.
- Handle open sharp-edged components with care.
- Make sure that the assembly location is clean and well organized. Components that are loosely stacked or lying around can cause accidents.
- Assemble components properly.
- Secure components so that they cannot fall or tip over.

5.1 Prerequisites and preparations

5.1.1 General requirements

Prerequisites for installation are influenced by the control unit's required operating conditions and must also take into account the machine to be controlled.

– *Ensure that the control unit's operating condition requirements are met.*
For further information see
Chapter 4.3 “Operating conditions” on page 78.

– *Ensure that the operating conditions requirements of the machine to be connected to the control unit are met.*
For further information see the CNC machine's manuals.

Electronic components (e.g. mainboards, power supplies, hard disks) have to be adjusted to the ambient air temperature before using. The components must not put to power until their temperature is the same as the ambient temperature.

5.1.2 Electrical cabinet structural requirements

The control unit must be installed in an electrical cabinet meeting the following minimum requirements.

Requirement	Value
IP protection class (DIN 40050/ IEC 60529)	IP 54
Mounting hole sizes and spacing	Standards defined in DIN 41494 ("Equipment practices for electronic equipment; mechanical structures of the 482.6 mm (19 inch) series; dimensions of electrical cabinets and suites of racks")

Fixed Values

NOTICE!

Control unit malfunctions

Excessive strain on cables can cause malfunctions due to disruption of connections.

– Install strain reliefs for all cable holes.

NOTICE!

For shielded cables it is necessary to apply the shield-screen at the cable inlet into the electrical cabinet.

5.1.3 Cabinet temperature

Notes

Heat input generated by fitted components

The heat generated by the operator's station influences the operating conditions inside the cabinet.

– *When installing the control unit, take the station's heat dissipation into consideration.*
– *Ensure an adequate cooling using fans or air conditioning.*

5.2 Mounting the control unit in a cabinet

Mounting Orientation

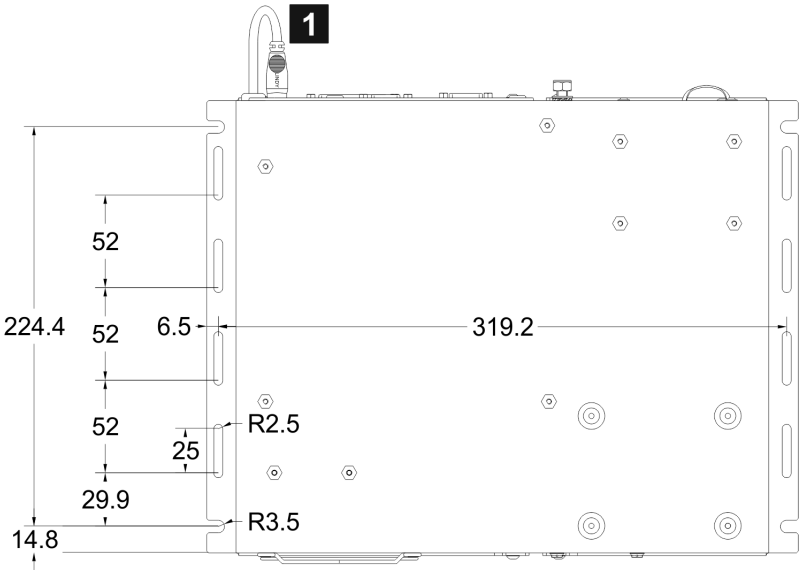


Fig. 51: Mounting orientation

- Always mount the control unit with the PC connector side facing up.

Spacing

Most of the CNC connectors (axes and inputs/outputs) are located on the front side.

- Ensure that there is clearance of at least 50 mm (2 inches) to allow accessibility to the connectors.

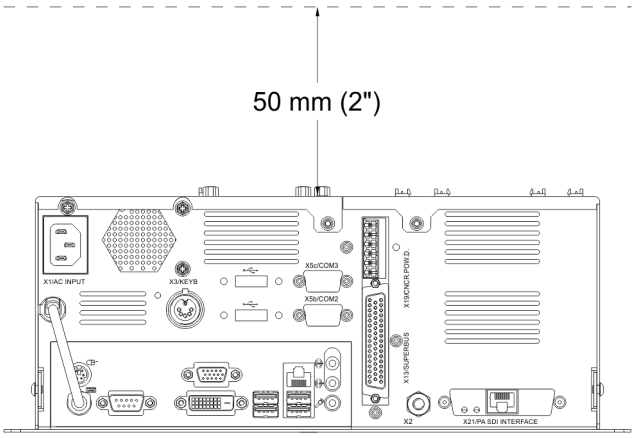


Fig. 52: Front spacing

Top / Bottom Spacing

All PC connectors (PS2, VGA, USB, etc.) and some CNC connectors (X13/X19 and the grounding screw) are located on the top side.

All PC connectors (PS2, VGA, USB, etc.) and some CNC connectors (X13/X19) are located on the top side.

- Ensure that there is clearance of at least 100 mm (4 inches) to allow accessibility to the connectors.

The PC connectors are shown as examples, and can vary from case to case.

On the bottom side of the control unit (opposite to PC connectors) is a grid for the air inlet.

- Ensure, that there is clearance of 40 mm (1.6 inches) at minimum for air circulation.

The cabinet fan provides internal air circulation for the control unit. Its proper operation is a prerequisite for safe operation of the control unit.

- Ensure that there is clearance of at least 30 mm (1.2 inches) next to the fan's exhaust.
- Install an additional fan inside the cabinet, directed toward the control unit.

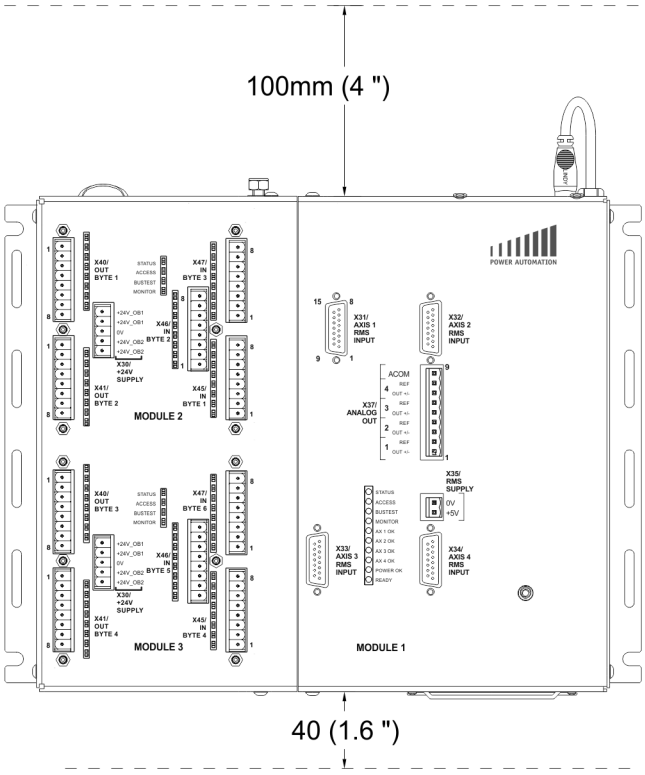


Fig. 53: Top/bottom spacing

Service access

For service or maintenance purposes access to the control unit may be necessary.

- Install the control unit and adjacent components in a way that allows for access to all mounting points, cables etc. by service personnel.

EMC Shield

Electrical noise may influence the control unit's operation.

- Locate the control unit at least 300 mm (12 inches) from areas which may transmit electrical noise.
  Electrical noise may be caused by components such as e.g. transformers, coils, drive amplifiers or relays.
- To decrease the influence of electrical noise, mount 1.5 mm (0.06 inch) metal shields between the control unit and the external electrical devices causing the noise. Connect the shields to a PE rail.

RF Noise Suppression

- Install noise suppression components for all coils, relays, valves, switching units, motor windings, other operator display panels and other RF noise producing devices.
- Connect noise suppression components directly at the noise source.
  If the distance to noise suppression components is several centimeters, use twisted pair cables to connect.
- Make sure, that noise suppressing capacitors have a low inductance and a good high frequency conductance.
- Conduct power and signal lines separately in a distance of at least 10 cm.
- When using mechanical cable guides, install additional metal shields.
- For all electrical installations, follow the rules of VDE 0113.

5.3 Installing analog axes

General

The following chapters provide instructions and examples for analog axes installation. Due to the versatility of the control unit, not all possible configuration options can be covered in detail.

- If in doubt, contact Power Automation's customer support.
  For contact information see ↳ *Chapter 9 “Service and return process” on page 113*.

5.3.1 Analog axes wiring example

The following schematics demonstrate the recommended way of connecting the CNC analog outputs to the analog inputs of the drives, depending on the analog input type of the drive.

Drives With Non-Differential Inputs (Unipolar)

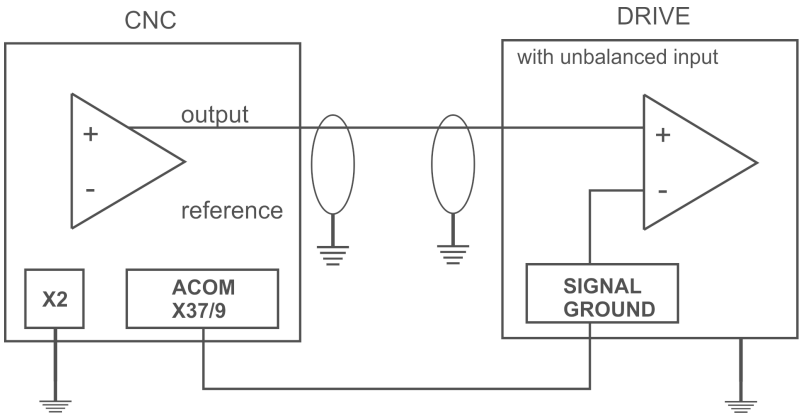


Fig. 54: Schematic non-differential inputs (unipolar)

Drives With Differential Inputs

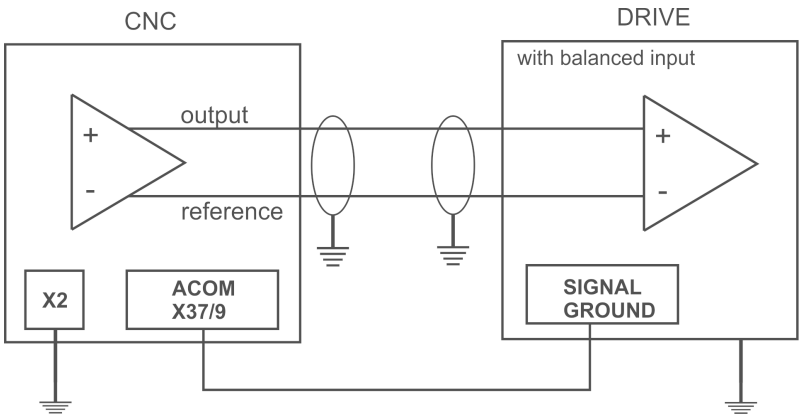


Fig. 55: Schematic differential inputs

5.3.2 RMS encoder wiring example

RMS Encoder Wiring Example

The following schematic demonstrates the recommended way of connecting the CNC RMS inputs to the encoders (or any other device with incremental output).

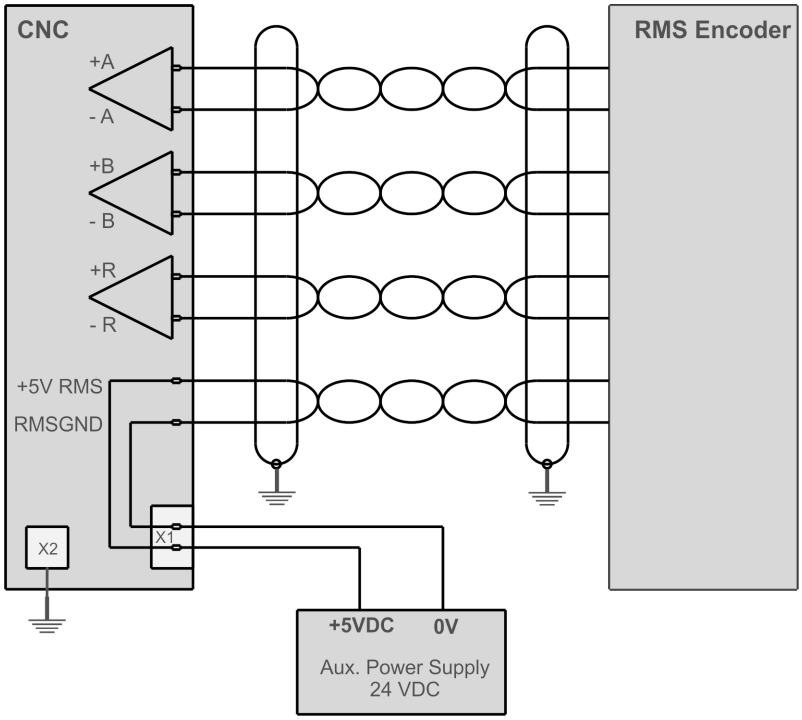


Fig. 56: RMS encoder wiring example

5.3.3 Setting up RMS supply voltage drop compensation

Precondition

The distance between the measuring systems and the power supply can be relatively long. The ohmic resistance of the power supply cable and the RMS' current consumption generate a voltage drop.

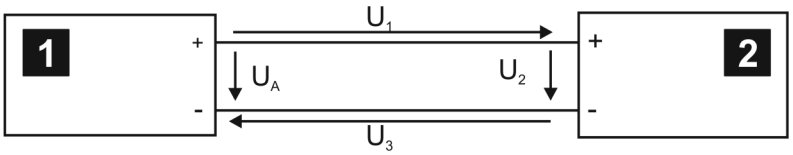


Fig. 57: Schematic encoder power supply voltage drop

1 Power supply
2 Rotating measurement system (RMS)
U_A Supply output voltage
U_1 Voltage drop
U_2 Voltage at the RMS
U_3 Voltage drop

As shown in the figure, the voltage U_2 equals the difference between the output voltage U_A and the voltage drop U_1+U_3.

Adjusted voltage	$U_2 = U_A - (U_1 + U_3)$

Examples

The voltage drop depends on the cable length and the conductor's cross section.

The following table shows some cable examples. The values are typical and only offered as guidelines.

- For proper compensation, calculate the actual values as shown in the following section.

Conductor cross section [mm²]/[AWG]	Specific resistance [Ω/m]	Cable length [m]	Voltage drop at 100 mA [V]
0.08 / AWG 28	0.235	10	0.47
		20	0.94
		35	1.65
0.14 / AWG 25	0.131	10	0.26
		20	0.52
		35	0.92
0.25 / AWG 23	0.075	10	0.15
		20	0.30
		35	0.53
0.5 / AWG 20	0.040	10	0.08
		20	0.16
		35	0.28
0.75 / AWG 18	0.025	10	0.05
		20	0.10
		35	0.18

Calculation

- Use the actual data obtained from the cable's technical specifications.
- Double the cable's physical length.
  This is necessary as there are two lines: one line to the RMS (+5 V) and one line from the RMS (grounding).
- Calculate the voltage drop as follows:

Voltage drop	[V] = 2 x L x C_R x P_C

L - Cable length [m]

C - C_R Specific resistance per meter [Ω/m]

P - P_C Power consumption [A]

Compensation

Personnel: ■ Skilled electrician

1. Install a power supply with adjustable output voltage to supply the RMS supply input.

   This is a requirement for voltage drop compensation.

2. Calculate the actual voltage drop between RMS power supply and RMS.

3. Adjust the external RMS power supply to feed a slight overvoltage of 5.1 V to 5.5 V depending on the measured drop.

A measurement system contains integrated electronic components. Relating to the current consumption Power Automation only indicates mean values. Current peaks of a multiple of the mean value may occur for several microseconds during operation.

- *Select a conductor cross-section which guarantees a maximum voltage drop of 0.2 V.*
- *Set the power supply to the upper limit of the RMS supply voltage.*

These steps guarantee that the RMS' supply voltage does not drop below the required minimum.

5.4 Installing digital I/O

General

The following chapters provide instructions and examples for installation of digital inputs and outputs. Due to the versatility of the control unit not all possible configuration options can be covered in detail.

- If in doubt, contact the Power Automation's customer support. For contact information see *Chapter 9 “Service and return process” on page 113*.

5.4.1 Wiring example for 2416EL modules

Schematic

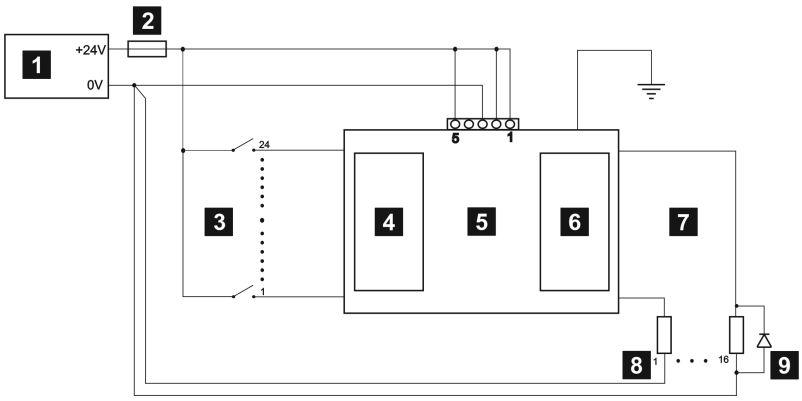


Fig. 58: Cabling example for 2416EL modules

1 Power supply
2 Fuse (slow)
3 Input signals
4 Inputs
5 Module 2416EL
6 Outputs
7 Output signals
8 Resistive load
9 Inductive load

Personnel: ■ Skilled electrician

1. Set up inputs according to the schematic.
2. Set up outputs according to the schematic.
3. Set up power supply for outputs.

   Ensure that the circuit is protected by a fuse of appropriate ratings.

Inductive loads

Digital outputs switch very quickly. This fact must be accounted for when inductive loads, like for example relays, are connected.

- When connecting inductive loads to outputs, ensure that a recovery diode is connected in parallel as shown in the schematic (pos. 9).

5.5 Wiring for machine safety

Safety

DANGER!

Uncontrolled operation due to improper installation and configuration!

The control unit's safety relay must be properly integrated into the CNC machine emergency stop chain. Improper wiring and configuration of the safety relay may result in uncontrolled operation of the CNC machine and in consequence may lead to irreversible personal injuries or death.

- Only operate the CNC machine if the safety relay has been properly integrated into the machine emergency stop chain.
- Only let **qualified personnel** (*Chapter 2.2.1 “Qualifications” on page 12*) set up the emergency stop chain.
- For information on safety devices integrated into the machine see the manual supplied by the machine's manufacturer.
- If in doubt regarding the configuration, contact the manufacturers of the control unit and the CNC machine.

For information on the safety connector's specifications and purpose see Chapter 3.6 “Safety connector” on page 68 and Chapter 2.8 “Machine safety” on page 17.

5.5.1 Wiring example for 'CNC ready' relay

Emergency Stop Interlocking

DANGER!

Injuries due to uncontrolled operation!

An inactive 'CNC Ready' signal represents a safety related situation. The "CNC Ready" relay is switched off when the PA CNC control unit is in a situation where the axes' movements are **not** controlled.

As the axes may continue to move in an uncontrolled manner, the contacts of the "CNC Ready" relay must be used to disconnect the machine's emergency stop safety chain. All actions necessary for safety must be executed in the same way as when the Emergency Stop button is pushed.

- Properly integrate the 'CNC ready' relay into the machine's emergency stop chain.

The contacts for 'CNC Ready' and 'Power OK' are available on connector X19 (see Fig. 59).

Schematic (Suggested Wiring)

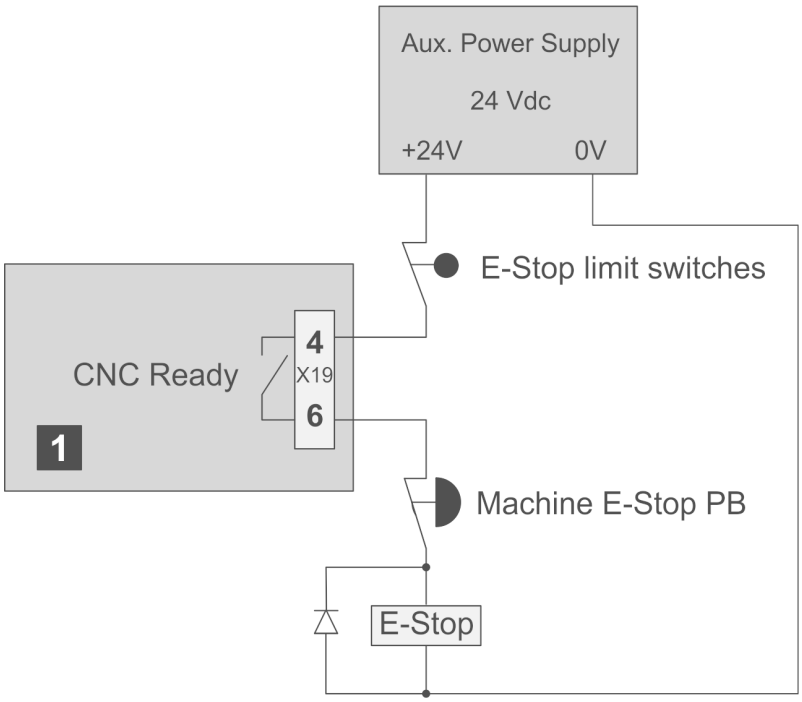


Fig. 59: Wiring example 'CNC ready' relay

4 connector X19 pin 4
6 connector X19 pin 6

5.5.2 Wiring example for 'Power ok' relay

Power Supply Interlocking

The "Power ok" relay is triggered by the hardware monitoring of the internal supply voltages and the temperature sensor.

The "Power ok" relay is switched off when the supply voltages do not match the allowed range or the internal temperature is too high.

- Use the contacts of the "Power ok" relay to switch off the main power supply of the CNC control unit unit to avoid any unexpected damages to the control unit.

The contacts for 'CNC Ready' and 'Power OK' are available on connector X19 (see Fig. 60).

Schematic (Suggested Wiring)

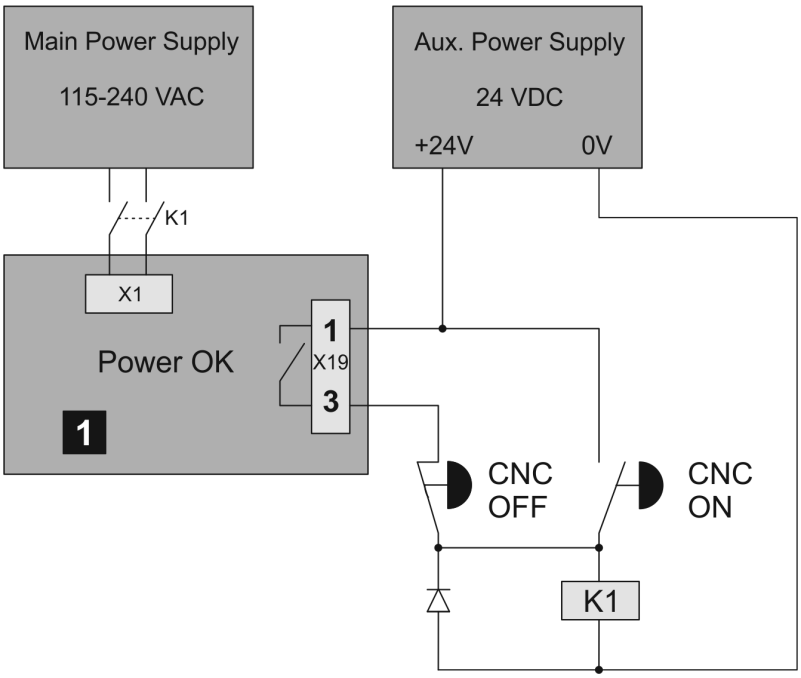


Fig. 60: Wiring example 'power ok' relay

1 Connector X19 pin 1
3 Connector X19 pin 3

6 Transport, packaging and storage

6.1 Transport

Inspection

Check the delivery immediately on receipt for completeness and transport damage.

Record the extent of transport damage in the transport documents or on the delivery note of the forwarding agent.

Complaint periods limited

Claim any damage as soon as it is detected. Compensation claims can only be submitted within the applicable complaint periods.

Improper Transport

CAUTION!

Improper transport can result in damage!

Improper transport can cause extensive material damage.

- When unloading the packages upon delivery and during in-house transport, exercise caution and observe the symbols on the package.
- Do not remove packaging material until control units are ready for assembly.

6.2 Packaging

Concerning Packaging

The individual packages have been packed to match the transport conditions that can be expected.

The packaging has the function of protecting the individual components against damage, corrosion, etc. until they are finally fitted. The packaging material must therefore not be damaged and should only be removed just before assembly is to take place.

Handling Packaging Materials

If there is no returns agreement for the packaging, separate materials according to type and size and direct to further use or recycling.

NOTICE!

Environmental damage caused by incorrect waste disposal!

Packaging materials are valuable raw materials and can be sensibly reconditioned and recycled in many cases.

- Dispose of packaging materials environmentally compliant.
- Follow the locally valid waste disposal regulations. If necessary employ a special waste disposal company to dispose of packaging material.

6.3 Storage

Storage Of Packages

Store packages under the following conditions:

- Do not store outdoors.
- Store in a dry and dust-free environment.
- Do not subject to aggressive media.
- Protect against direct sunlight.
- Avoid mechanical vibrations.
- For storage periods longer than 3 months check the general condition of all parts and packaging regularly.
- If necessary renew the packaging.

Storage Conditions

Property	Value	Unit
Temperatures	-20 - +60	°C
	-4 - +140	°F
Humidity (non-condensing)	< 80	%
Acceleration	< 4.0	G

Additional requirements

Packages may be marked with notes for storage, which may exceed the requirements mentioned here. These must be adhered to.

Improper Storage

CAUTION!

Improper storage can result in damage!

Improper storage can cause extensive material damage.

- Always store the control unit in its original packaging.
- When storing the control units observe the specifications regarding maximum and minimum storage temperature and permitted maximum acceleration given in chapter "Technical data" (*Chapter 4 “Technical data” on page 77*).

7 Maintenance

7.1 Safety notes

Personnel

Some maintenance tasks can only be executed by trained qualified personnel, or only by Power Automation. In these cases this is separately indicated in the description of the specific maintenance tasks. All work on the electrical equipment shall only be executed by a qualified electrician.

Safety Messages

DANGER!

Danger to life caused by electric current!

Touching conductive parts causes a direct danger to life. Damage to insulations or individual components can cause danger to life.

NOTICE!

Property damage due to improperly executed maintenance work!

Improper maintenance can cause property damage.

- Prior to starting work ensure that there is sufficient assembly space.
- Ensure order and cleanliness at the assembly site! Loose parts and tools or parts and tools placed on top of each other are hazard sources.
- If components have been removed, ensure that they are properly mounted; re-install all mounting elements and comply with standard screw tightening torque specifications.

7.2 Maintenance schedule

Maintenance tasks that are required for optimum and trouble-free operation are described in the sections below. If increased dust pollution is detected at regular inspections do the following:

- Shorten the required maintenance intervals to correspond with the actual signs of pollution.
- Check, whether the cabinet still adheres to the requirements of its protection class (IP).

For questions on maintenance work, contact Power Automation Service (*Chapter 9.1 “Service” on page 113*).

Schedule

Interval	Maintenance work	Personnel
Once a year	Visual check, whether all fan exhausts are clean and the fans are properly working. ■ If required, clean the fan exhausts with a dry cloth or if necessary use a vacuum cleaner.	Instructed person
	Check whether all fans inside the electrical cabinet are operating accordingly. ■ Use a sheet of paper and keep it in front of the fans inside the electical cabinet to check if it is moving.	Instructed person
	Check whether all interface cables are installed properly in their respective sockets. ■ Before re-plugging loose cables, properly shut down the control unit and machine and secure against inadvertent restart. ■ Unplug the respective cables and re-plug them afterwards. ■ Follow instructions in ↳ *Chapter 7.3 "Measures after maintenance" on page 102*.	Instructed person
	Make a backup of the data. ■ For the exact procedure to make the backups see ↳ *Chapter 2.10 "Data safety" on page 20*.	Skilled electrician

7.3 Measures after maintenance

Perform the following steps after completing maintenance and before switching on the control unit and the machine:

1. Check all previously loosened screw connections for a tight fit.
2. Check whether all previously removed protective devices and covers are properly installed again.
3. Make sure that all tools, materials and other equipment used were removed again from the cabinet.
4. Clean up work area and remove any substances left over, such as fluids, cleaning material or the like. Dispose them according to the current applicable regulations.
5. Make sure that all safety features on the control unit and relating to the machine are fully functional.

8 Troubleshooting

General Information

The following chapter describes possible causes of faults during installation and configuration and the steps required to eliminate them.

- In the event of frequent faults, re-check if the configuration was set up as described in this installation manual.
- In the event of faults that cannot be eliminated through the following instructions, please contact Power Automation (see *Chapter 9 “Service and return process” on page 113*).

Return procedure

In the event of an error that requires the control unit to be sent to Power Automation, follow the instructions given in Chapter 9.3 “Return policy and procedure” on page 115.

8.1 Safety notes

Personnel

- The troubleshooting procedures described in this installation manual can be performed by the operator unless otherwise marked.
- Some work may be performed only by specially trained personnel or only by Power Automation, in which case special notice is given in the description of the individual faults.
- All work on the electrical system must be performed by a qualified electrician.

Authorization

WARNING!

Unauthorized troubleshooting procedures can result in injury!

Improper troubleshooting procedures can result in severe personal injury or material damage.

- Observe the personnel requirements for repairs specified in the troubleshooting chart.

  If in doubt, contact Power Automation for help or support by an authorized service technician.
- Ensure that the power supply has been disconnected.
- Make sure that the assembly location is clean and well organized.
- Components that are loosely stacked or lying around can cause accidents.
- If components have been removed, ensure proper assembly, install all mounting elements and comply with screw tightening torques.

In Case Of Faults

The following general rules apply:

Personnel:
- Qualified personnel

Protective equipment:
- Ground strap
- ESD safety shoes
- ESD safety pad
- ESD clothing
- Protective glasses
- Ear protection
- Antistatic gloves

1. In the event of faults that pose immediate danger to man or machine, activate the emergency shutoff function immediately.
2. Determine the cause of the fault.
3. Disconnect the control unit from power supply.
4. Immediately inform the person in charge of the equipment where the fault is located.
5. Depending on the type of fault, eliminate the fault or have it eliminated by an authorized specialist.

8.2 Malfunction indicators

Overview

The following components indicate malfunctions or improper configuration of the control unit.

Module	Description
4AXLX LEDs	The LEDs of the 4AXLX module indicate operating states and malfunctions regarding analog axes inputs and outputs.
2416 EL LEDs	The LEDs of the 2416EL module indicate operating states and malfunctions regarding digital inputs and outputs.

8.2.1 Module 4AXLX LEDs

Overview

The 4AXLX module has ten LEDs for diagnostic purposes.

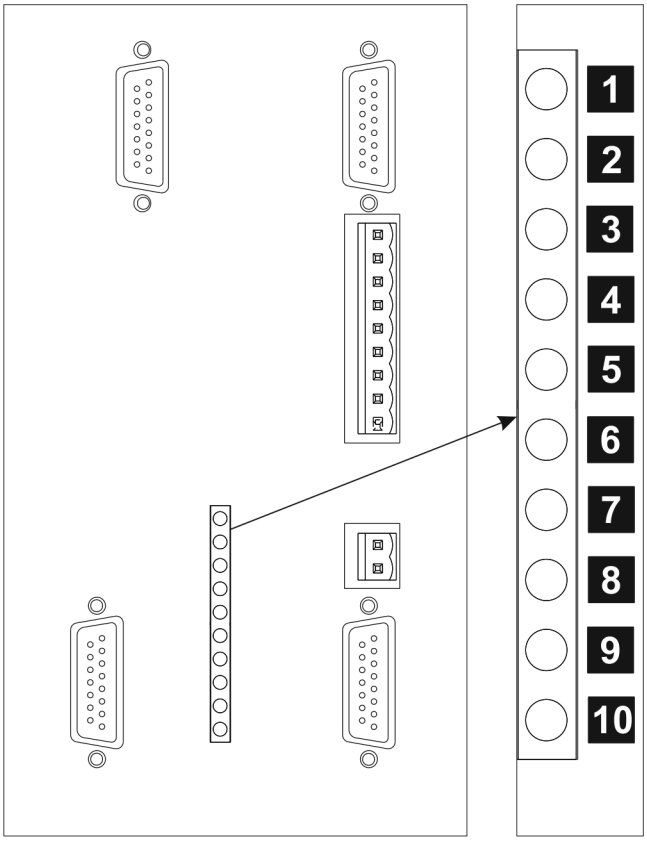


Fig. 61: Status LEDs

1 Status
2 Access
3 Bustest
4 Monitor
5 Axis 1
6 Axis 2
7 Axis 3
8 Axis 4
9 Power OK
10 CNC Ready

The LEDs' states are assigned the following status messages:

LED "Status" (1)

LED state	Module status
Off	No power supply (24 V)
OR	Hardware error
Slow flash	The module is not configured
Quick flash	The module is configured and the analog outputs are set to 0 V
On	The module is configured and the analog outputs are enabled

LED "Access" (2)

LED state	Module status
Off	Default
On	Access to this module

LED "Bustest" (3)

LED state	Module status
Off	Default
On	Bustest between control unit and the last PAMIO module is active

LED "Monitor" (4)

LED state	Module status
Off	Error: The ambient temperature is above 60 °C (140 °F). and all analog outputs are set to 0 V
Flashing	Warning: The ambient temperature is above 55 °C (131 °F)
On	Default

LED "Axis 1" (5)

LED state	Module status
Off	Axis is not connected
OR	Axis is connected and an encoder wire break has been detected
Flashing	Axis is connected and a wrong sequence of signals on track A and B has occurred
On	Axis is connected and no wire break has been detected (default)

LED "Axis 2" (6)

LED state	Module status
Off	Axis is not connected
OR	Axis is connected and an encoder wire break has been detected
Flashing	Axis is connected and a wrong sequence of signals on track A and B has occurred
On	Axis is connected and no wire break has been detected (default)

LED "Axis 3" (7)

LED state	Module status
Off	Axis is not connected
OR	Axis is connected and an encoder wire break has been detected
Flashing	Axis is connected and a wrong sequence of signals on track A and B has occurred
On	Axis is connected and no wire break has been detected (default)

LED "Axis 4" (8)

LED state	Module status
Off	Axis is not connected
OR	Axis is connected and an encoder wire break has been detected
Flashing	Axis is connected and a wrong sequence of signals on track A and B has occurred
On	Axis is connected and no wire break has been detected (default)

LED "Power OK" (9)

LED state	Module status
Off	The power supply voltage for the onboard logic is outside its tolerances
OR	The ambient temperature is above 60 °C (140 °F)
On	The power supply voltage for the onboard logic is in rated range
AND	The +/- 15 V supply voltage for the analog I/O functions is in rated range
AND	The ambient temperature is below 60 °C (140 °F) (rated range)

LED "CNC Ready" (10)

LED state	Module status
Off	The CNC is not ready (see *Chapter 2.7 "Safety devices" on page 17*) or the power supply for the RMS is outside of the tolerated values or the ambient temperature is T>55 °C (131 °F). In all these cases, the analog outputs are set to 0V.
On	The CNC is ready (see *Chapter 2.7 "Safety devices" on page 17*), the power supply for the RMS is in rated range and the ambient temperature is T<55 °C (131 °F). The analog outputs are released.

NOTICE!

A wrong sequence of axis signals is detected when the A and B track of an incremental measuring system shows incorrect sequence of rising and falling edges. This can occur in case of:

- Interferences on the signals
- Status directly after power-up
- Signal frequency is too high
- Phase displacement between the input signals is unlike 90°°

8.2.2 Module 2416 EL LEDs

Overview

The 2416 EL module has four LEDs for diagnostic purposes.

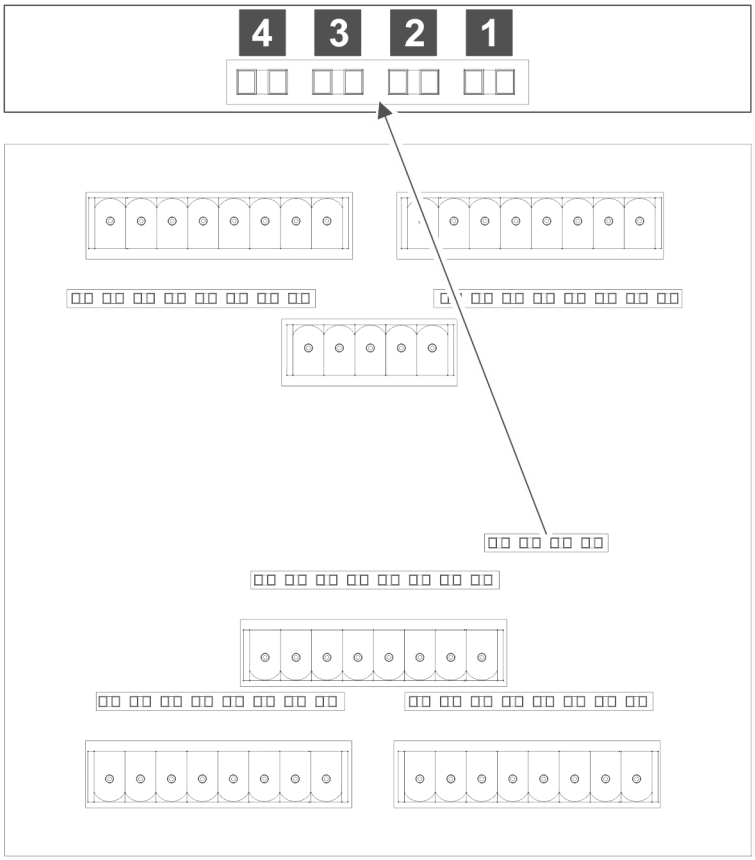


Fig. 62: Status LEDs

1 Status
2 Access
3 Bustest
4 Monitor

The LEDs' states are assigned the following status messages:

LED "Monitor" (1)

LED state	Module status
Off	Error 1: The ambient temperature is above 60 °C (140 °F) and all outputs are disabled by the onboard logic
OR	Error 2: The watchdog is re-triggered but the 24 V output supply has been interrupted for more than 60 seconds. In this case the onboard logic switches off the corresponding 24 V outputs.
Quick flash	Warning 1: The ambient temperature is above 55 °C (131 °F)
OR	Warning 2: The watchdog is re-triggered but the 24 V output supply has been interrupted for more than 15 seconds
OR	Warning 3: Outputs are overloaded for more than 15s.
On	The 24 V output supply is correct
AND	There is no temperature error

LED "Bustest" (2)

LED state	Module status
Off	Default
On	Bustest between control unit and the last PAMIO module is active

LED "Access" (3)

LED state	Module status
Off	Default
On	Access to this module

LED "Status" (4)

LED state	Module status
Off	No power supply (24 V)
OR	Hardware error
Slow flash	The module is not configured
Quick flash	The module is configured but the outputs are disabled because the watchdog is not re-triggered
On	The module is configured and the analog outputs are enabled

8.3 Troubleshooting chart

Notes

Malfunctions or errors not listed in this chart require Power Automation to be contacted (see ↳ Chapter 9 “Service and return process” on page 113).

- *Do not attempt repairs not described in the troubleshooting chart or the following chapters. Attempts at unauthorized repairs void the material warranty.*
- *If in doubt regarding listed repairs, contact Power Automation for help.*

Return procedure

In the event of an error that requires the control unit to be sent to Power Automation, follow the instructions given in ↳ Chapter 9.3 “Return policy and procedure” on page 115.

General Procedure

Personnel:
- Qualified personnel
- Skilled electrician

1. Properly shut down the control unit and the tooling machine.

   Ensure the tooling machine rests in a secured state.
2. Ensure the power supply is deactivated and secured against inadvertent reactivation.
3. Follow the instructions given in the troubleshooting chart.
4. Restart the control unit and the tooling machine after termination of the work as described in the respective operating manuals.

Troubleshooting Chart

No.	Error	Cause	Solution	Personnel
001	Unscheduled shutdown	Overheating	■ Ensure that all requirements regarding spacing within the cabinet are met (↯ *Chapter 5.2 “Mounting the control unit in a cabinet” on page 87*). ■ Ensure that the ambient temperature is within the specified limits (↯ *Chapter 4.3 “Operating conditions” on page 78*). ■ Ensure that none of the vents are blocked. ■ Check visually/aurally if the fans are working. If not, contact Power Automation	Skilled electrician
		Missing power supply	■ Check if the power supply wiring is set up correctly. ■ Ensure, that the external main power supply is working.	Skilled electrician
002	Hardware failure	Undetermined	■ Return the control unit to Power Automation for repair. Follow the instructions given in ↯ *Chapter 9.3 “Return policy and procedure” on page 115*.	Instructed person
003	Malfunction of the control unit	Undetermined	■ Contact Power Automation in case of malfunctions relating to the control unit's startup and date/time settings. ■ Do not open the casing or replace the battery manually! ■ Please contact the Power Automation service (see ↯ *Chapter 9 “Service and return process” on page 113*).	Skilled electrician
004	Missing RF noise suppression	Undetermined	■ Check if the noise suppression components are connected directly at the noise source. ■ Check if the power and signal lines are conducted separately in a distance of at least 10 cm. ■ When using mechanical cable guides, install additional metal shields.	Skilled electrician
005	Uncontrolled operation	Inactive 'CNC Ready' - signal	■ Check if the 'CNC ready' relay is properly integrated into the machine's emergency stop chain (see ↯ *Chapter 5.5.1 “Wiring example for 'CNC ready' relay” on page 96*).	Skilled electrician

9 Service and return process

9.1 Service

Service At Power Automation

By Phone

PA's well-educated service staff is available to answer your technical questions. Due to the close co-operation with our customers, our engineers can solve problems often immediately by phone.

If on-site support is necessary, our service staff will diagnose the problem and will prepare our field service engineer beforehand. This is to make on-site service as much effective as possible

By Remote Control Software

Every PA CNC is equipped with an Ethernet interface. If you have a network on-site, you only have to integrate the CNC system to your network for world-wide-web access.

Power Automation provides a remote control software which allows our service staff to log into your CNC. This provides all the information available on the machine. They can check all the data like the PLC program, machine parameters, or the NC programs directly on the real system under real conditions. This is the fastest and most cost-effective way to solve problems.

On-Site

If neccessary our service engineers will visit you to help you solve your problems on-site. Our engineers are trained continuously to be always up to date. Thereby you always can expect the best support.

Due to our service centers worldwide, our service staff can be on site normally within 24 hours at the latest.

9.1.1 Service addresses

Service Addresses

Power Automation GmbH (Headquarter)

Gottlieb-Daimler-Strasse 17/2

D-74385 Pleidelsheim

Tel: +49-7144-899-0

Fax: +49-7144-899-299

service@powerautomation.com

Service and return process

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Houston, Texas 77040 USA
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Fax: +1-281-715-2500
sales.america@powerautomation.com

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Kustepe Mah. Mecidiyekoy Yolu Cad.
Trump Towers No. 12 Kule: 2 K:18
Daire no: 3211022839 Sisli / Istanbul
Turkey
Tel: +90-212-306-3280
Fax: +90-212-306-3101
sales.turkey@powerautomation.com

Shenzhen Double CNC Tech Co., Ltd
8th Floor,WeiXinDa Building
Bao Min Road 2
Xi Xiang Town
Bao'an District, Shenzhen, Guangdong
PR China

Power Automation France SARL
Cité de la Photonique
Bâtiment Pléione
11 avenue Canteranne
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France
Tel: +33-559-4010-50
Fax: +33-559-4010-59
pa.france@powerautomation.com

ACE Automation

A-721, Twinrex B/D

Deokpungdong-ro 111-10, Hanam-si

Gyeonggi-do, 465-831

South Korea

9.2 Spare parts

Spare Parts

Due to the high quality of our products we can assure you that you will not need this service often. Spare parts are often urgent so Power Automation provides the relevant spare parts at the local service centers for immediate dispatch.

Our 3 service centers in Europe, North America and Asia allow us to deliver all needed parts typically within 24 hours.

Only trust PA's original parts - because every part passes our tight quality checks.

We also offer consulting services to identify the most critical parts for the machines in your production facilities. We suggest what critical stock may be required to ensure a minimum downtime of your machines. Our specialists look for common parts to keep your inventory levels at a minimum.

9.3 Return policy and procedure

Policy

Power Automation will only accept control units and components for replacement or repair, if they have been returned in adherence to the provisions given below.

- If material warranty is void or if no error is detected, a testing flat rate will be charged. For present values please contact the Power automation Service ↬ *Chapter 9.1.1 “Service addresses” on page 113*
- If material warranty is void you will receive a repair offer.
- Before the repair starts we need a repair order from you.
- Power Automation will impose a rate for the estimate of costs which will be absorbed if a repair order is coming about.

Acquiring RMA Number

1. Contact Power Automation to receive an RMA form in Excel format. *“RMA Form” on page 117*
2. Open the 'RMA Process' form provided by Power Automation.

   Use one form for each single part you want to ship back to Power Automation.
3. Fill in the form.

   The fields marked with a red star (*) are mandatory fields.

   Only fill in the fields next to the yellow bar on the left side of the form.

   Do not fill in the fields next to the blue bar on the left side of the form. These fields are for internal notes only and blocked.
4. Send the completed form as Excel file by email to **rma@powerautomation.com** to your local support (see webpage).

   ⇨ We will check the data and send the form back to you as a PDF file including a RMA number or tell you what information is missing if necessary.
5. Print the RMA form and add it to the accompanying components and documents.
6. After the check and repair the components will be shipped to you immediately.

RMA Form

RMA Formular - Vom Kunden auszufüllen / **RMA Form** - To be filled out be customer

Kontakt bei PA / Contact at PA: *

Datum / Date: 05.06.2014

Kunde / Customer:

(Unternehmen / Company) *

(Kundennummer / Customer No.) *

(Adresse / Adress) *

(Name / Name) *

(Telefon / Phone) *

(Fax / Fax)

(eMail / eMail)

POWER AUTOMATION

Return of Material Authorization

Power Automation GmbH
Gottlieb-Daimler-Strasse 17/2
74385 Pleidelsheim
Germany
Phone: + 49 (0) 7144/899 - 321
Fax: + 49 (0) 7144/899 - 299
E-Mail: rma@powerautomation.com

Artikelbezeichnung / Part Description : *

☐ PA 8000 e ☐ PA 8000 L2 ☐ PA 8000 NT ☐ Zubehör / Accessories ☐ Antrieb / Drive ☐ P1, P2, other
☐ PA 8000 e2 ☐ PA 8000 LW ☐ PA 8000 EL ☐ Bedienfeld / Panel ☐ Motor

Seriennummer / Serial No.: *

Lieferschein-Nr. / Delivery Note No.: *

☐ Express

Sofortige Bearbeitung garantiert! Es entstehen zusätzliche Kosten!!

Grund der Warenrücksendung / Reason for return of the goods:

☐ Musterrücksendung / Sample Return ☐ Reparatur / Repair ☐ Andere / Other
☐ Gutschrift / Credit ☐ Umbau / Conversion

Detaillierte Fehlerbeschreibung / Detailed Error Description, Notizen / Notes, ...: *

*** = Pflichtfeld / Mandatory Field**

To be filled out by Power Automation

Interne Vermerke / Internal Notes:

☐ **RMA Nummer erteilen / Accept RMA number**

☐ RMA Nummer nicht erteilen / Reject RMA number

Zuständig bei PA / Responsible at PA:

RMA Nummer / RMA number:

Vermerke / Notes

(Unterschrift / Signature)

(Stempel / Chop)

Wichtige Hinweise / Important indications:

Außerhalb der Gewährleistung wird eine Testpauschale von 100€ berechnet / Out of warranty period a testing flat rate of 100€ will be charged
Bitte verpacken Sie die Ware angemessen / Please pack the goods in an adequate way
Steuerungen können nur in Originalverpackung oder gleichwertiger Verpackung angenommen werden / Contrds can only be accepted in original enclosures or equivalent
Power Automation haftet nicht für Transportschäden/ Power Automation does not bear any liability for damages in transit
Lieferungen werden nur FREI angenommen / Deliveries are only accepted FREE DOMICIL
Lieferungen ohne RMA Nummer werden nicht angenommen/ Deliveries without RMA Number will be rejected
Die RMA Nummer muss am Karton außen gut sichtbar sein / The RMA number must be visible well from outside the cardbox
Das RMA Formular muss den Begleitdokumenten beigefügt sein / The RMA form must be added to the accompanying documents

Fig. 63: RMA Form

Return

1. Pack the goods properly.

   Controls must be packed in original or equivalent packaging.

> **NOTICE!**
>
> **Damages due to inadequate packaging**
>
> Inadequate packaging may result in damages to the control unit. This will void the material warranty. PA does not bear any liabilities for damages in transit.

2. Write the RMA number on the cardboard box clearly readable from outside.

   The incoming goods department rejects all deliveries without a visible, valid RMA number.

3. Ship the goods FREE DOMICILE / DDU. Other deliveries will be rejected.

   The goods have to arrive within 4 weeks after the date of the approved RMA form.

9.4 Training

Training Courses

Having the best CNCs is one thing, to bring out the best of it is the other.

The PA training program comprises of a number of individually combinable training modules which offer you a well-founded knowledge for using PA CNCs. At our training centers we bring your employees - beginners and experts- up to the scratch in CNC technology. We also offer individual training courses at your site. The contents of the courses will be customized to your requirements.

Fpr more information see *Chapter 9.1.1 “Service addresses” on page 113*.

10 Dismounting and decommissioning

When the control unit has reached the end of its service life it must be dismounted and disposed of in an environmentally responsible manner.

Dismounting

Personnel: ■ Qualified personnel

1. Ensure that the machine connected to the control unit rests in a safe state.
2. Disable the external power supply.
3. Disconnect the power supply cable.
4. Disconnect all input, output and interface wiring.
5. Secure the control unit against unwanted movement.
6. Loosen the screws that fix the control unit inside the cabinet.
7. Dismount the control unit.

Decommissioning

Electronic components are considered special waste. They must be properly disposed of.

Power Automation will accept the control unit to properly dispose of its components upon decommissioning.

To return the control unit follow the instructions given in ↬ Chapter 9.3 “Return policy and procedure” on page 115.

CAUTION!

Environmental hazard caused by incorrect handling!

Incorrect handling of environmentally hazardous substances, especially incorrect waste disposal, can cause considerable damage to the environment.

Dismounting and decommissioning

11 EC Declaration of Conformity

EC Declaration of Conformity

Original

POWER AUTOMATION

EC-Declaration of Conformity

The units in the **PA 8000 LW** series are intended for installation in a machine or for assembly with a machine. They are no more than components of a machine and can therefore not conform to the required standards and guidelines that are applicable to the complete installation. The applicable connection conditions of the control system must be observed.

Device designation:	CNC-Control Unit
Series:	PA 8000 LW xxx *)
Manufacturer:	Power Automation GmbH Gottlieb-Daimler-Str. 17/2 D-74385 Pleidelsheim

The product described above in the form as delivered is in conformity with the provisions of the following European Directives:

- *2004/108/EC (Electromagnetic compatibility)*
- *2006/95/EG (Low Voltage)*
- *2011/65/EU (RoHs-Directive)*

The following standards are fulfilled:

- *EN 60204-1 (VDE 0113-1) (Electrical equipment of machines)*
- *EN 55011:2009 + A1:2010 Class B (Radio-frequency disturbance characteristics)*
- *EN 55022:2006 + A1:2007 Class B (Radio Disturbance Characteristics)*
- *EN 61000-6-3:2007 (Emission standard)*
- *EN 61000-3-2:2006 + A1:2009 + A2:2009 (Net harmonic components)*
- *EN 61000-3-3: 2008 (Harmonic current emissions)*
- *EN 61000-4- 2 (ESD 4KV Electrostatic discharge)*
- *EN 61000-4- 3 (HF-radiation 80-1000 MHz, 10 V/m)*
- *EN 61000-4- 4 (Burst 2 KV power line, 1 KV signal line / data line)*
- *EN 61000-4- 5 (Surge 1 KV symmetric, 2 KV unsymmetric)*
- *EN 61000-4- 6 (HF-power input 10V into net, signal line / data line)*
- *EN 61000-4- 8 (Magnetic field 50 Hz, 30 A/m)*
- *EN 61000-4-11 (Voltage dips and interruptions)*
- *IEC/EN 61000-6-2:2005 (Immunity)*

Pleidelsheim, 24th June 2014

General Manager

Manager QA

*) Specification of the control unit

PA8000LW_EC_DECLARATION OF CONFORMITY_EN_REV02_140624

Power Automation GmbH
CNC-Automatisierungstechnik
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VAT-Ident.-No.
DE-811563976
Tax number: 71390/00450

Banking account
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Account-No.: 027745900
Bank Code: 604 700 82
IBAN: DE54604700820027745900
BIC: DEUTDESS604

Postbank AG Stuttgart
Account-No.: 48816705
Bank Code: 600 100 70
IBAN: DE40600100700048816705
BIC: PBNKDEFF

Fig. 64: EC Declaration of Conformity

12 Proof of change

Proof Of Change

Version	Change	Date
1	Original Version	06/27/2013
2	Revised Version Chapter 9, 11 and 12 included	11/28/2014

Proof of change

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